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AN OPTIMAL ALLOCATION OF RECRUITER AND FACILITIES
IN THE 12th MARINE CORPS DISTRICT

by

James M. Doll

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Thesis Advisor: George W. Thomas

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The recommendations are: align the recruiting force to exploit the location of aptitude category I-IIIA individuals by using the county recruited allocation model, use the facility reduction model which maximizes PQMA to close excess recruiting facilities, attempt to operate two recruiter facilities as the preferred manning level and consider further research on the optimal allocation of the entire Marine Corps recruiting force.

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An Optimal Allocation of Recruiter and Facilities in the 12th Marine Corps District

by

James M. Doll
Captain, United States Marine Corps
BCE, Villanova University, 1980

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Author: James M. Doll
James M. Doll

George W. Thomas
George W. Thomas, Thesis Advisor

R. R. Read
Robert R. Read, Second Reader

P. Purdue
Peter Purdue, Chairman
Department of Operations Research

ABSTRACT

This thesis studies category I-IIIA all-service accessions at the county level in the 12th Marine Corps District. A production function is presented to model Marine Corps accessions in the 12th District using Propensity weighted Qualified Military Available (PQMA) and the number of recruiters. The recruiting force is allocated according to this nonlinear production function and a "greedy" algorithm to obtain an integer, heuristically optimal allocation. Each recruiting facility's value is determined by its number of recruiters and the PQMA in the county. A 10% recruiting facility reduction plan is proposed by using an optimal facility allocation model that maximizes the pool of aptitude category I-IIIA potential enlistees. Finally, a determination of the "best" facility manning level is presented as a recruiter assignment decision aid.

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- align the recruiting force to exploit the location of aptitude category I-IIIA individuals by using the county recruiter allocation model,

- use the facility reduction model which maximizes PQMA to close excess recruiting facilities,

- attempt to operate two recruiter facilities as the preferred manning level and consider further research on the optimal allocation of the entire Marine Corps recruiting force.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

A. ARMED FORCES RECRUITING

The emergence of an all volunteer Armed Forces in 1973 placed the services in a truly competitive environment for recruiting qualified individuals. As military pay rose to compete with civilian wages, the services struggled to improve an often negative image. Initially, the quality of enlistees for all services suffered as the military began its recovery from the painful experiences of the Vietnam era [Ref 1]. As public perception of the military slowly improved and military wages came into rough parity with the civilian market, the Armed Forces seized the opportunity to improve the quality of the force.

Among the most important factors influencing the emphasis on quality were the substantial wage increases enacted in the Carter administration, a significant recession in the early 1980's and unabashed support for the military championed by the Reagan administration. From 1973 to 1980 the services only met required end strength by enlisting a substantial number of non high school graduate, lower aptitude, morally undesirable applicants. In the early 1980's strong, conspicuous effort was devoted to improving quality while meeting required end strength. The military buildup of the early to mid 1980's introduced a large number of high technology systems requiring skilled operators and technicians in all the services. The direct emphasis on improving the quality of recruits and better environmental

conditions positively affected the military's ability to attract the high calibre individuals.

Towards the end of the 1980's to the present, the onset of a recession and declining perception of the threat (due greatly to the collapse of the Soviet Union) forced the armed services into a new environment. The services now face significant reductions in force structure which will eventually result in a lesser demand for raw numbers of accessions. Declining force size and decreased funding is affecting all areas of the military. All service branches face recruiting budgets mirroring the decreased demand for new accessions. Reduced funding has pressured each service to reduce recruiters and recruiting facilities. The reduced need for new accessions, a pool of enlistable individuals that is flattening out after a number of years of constant decline and a greater reliance on female enlistments allow the services to continue to pursue their objective of attracting high quality applicants.

Finding high quality individuals with strong propensity to enlist requires the location of recruiting facilities geographically close to the quality market. Currently, recruiting facilities are not always located in areas that best support the recruiting mission. In the past, there was no clear method for determining the location and necessity of new facilities. Closing existing facilities was low priority, time consuming and often poorly planned. Consequently, the allocation of facilities has not kept pace with changing demographics or quality demands. The lack of methodical planning in locating facilities, the historical difficulty in closing nonproductive facilities and an understandably parochial view of local commanders and policy makers produced a

system for facility closure based on influence and blanket initiatives devoid of quantitative analysis. The current climate and the forseeable future demands reduction in recruiting assets, including recruiting facilities.

B. MARINE CORPS RECRUITING

Much research has been completed on the factors that predict future success at the time of enlistment. The Marine Corps generally uses two measures for determining a "successful" Marine. The first is completing 45 months of service and the second is achieving the rank of Corporal during the first term enlistment. Two factors that most accurately predict success at the time of enlistment are high school completion and aptitude classification on the Armed Forces Qualification Test (AFQT) or Armed Forces Vocational Aptitude Battery (ASVAB). Overwhelmingly, the best predictor is the achievement of a high school diploma. This is clearly evident in that 66% of high school graduates complete 45 months of service while only 42% of non graduates complete the initial service period [Ref 2]. The aptitude classification shows little difference in first term completion rates but job performance studies found substantial differences between the performance of lower and higher aptitude Marines [Ref 3]. The success rate of individuals achieving the rate of Corporal is significantly less for lower aptitude Marines. The huge expense of training individuals who fail to complete a first enlistment and the poor success rate training lower aptitude individuals mandates special emphasis on identifying individuals most likely to be successful. Thus, evidence strongly suggests that identifying and actively recruiting higher aptitude, high school graduates is a very cost

effective means of reducing training expenses and developing a more skilled, productive Marine. The Marine Corps Recruiting Service is geographically organized into six districts (first, fourth, sixth, eigth and twelfth). Each district controls six to nine recruiting stations (RS). Under each recruiting station is a varying number of recruiting facilities based on the size of the area covered and the number of prospective applicants within the recruiting station's geographic boundaries. In these facilities direct recruiting activities are undertaken by canvassing production recruiters (recruiters on quota). The three types of recruiting facilities are the recruiting substation (RSS), permanent contact station (PCS) and the transient recruiting facility (TRF). The recruiting substation is a permanently manned office of generally two to six recruiters one of whom is the noncommissioned officer in charge who may or may not be a recruiter on quota (often referred to as "on production"). The recruiting substation normally controls as many as three satellite facilities (Permanent Contact Stations and Transient Recruiting Facilities). Each permanent contact station or transient recruiting facility is the responsibility of a specific recruiting substation noncommissioned officer in charge.

Marine recruiters are evaluated on the basis of their effectiveness in recruiting a sufficient number of high quality recruits. The purpose of the recruiting office is to assist the recruiter in this objective by equipping him with a professional looking office in a location where he or she can most effectively make contact with the largest number of high quality applicants possible. Each canvassing recruiter should have roughly the same opportunity as his peers to contact prospective applicants.

C. OBJECTIVES

The Army Corps of Engineers administers an approximately 100 million dollar budget for rental and upkeep of all services' recruiting facilities. Facing budgetary realities, the Marine Corps has been tasked by the Army Corps of Engineers with reducing 10% of existing facilities while the prospect of even more dramatic reductions is likely. It is imperative to conduct quantitative research to determine the facilities most critical to the Marine Corps in obtaining quality enlistments. The objective of this thesis is to examine existing recruiting facilities thoroughly in relation to the "quality market" and develop a model to determine those facilities which best support the recruiting mission.

D. RESEARCH QUESTIONS

The 12th Marine Corps District, one of six districts, which includes nine western states was selected for analysis because of its obvious diversity in population density, lifestyles, ethnicity, and education; its manageable size, (population, counties, accessions) and its proximity. The primary research question is, "Which recruiting facility closures would least affect productivity in the 12th District?" The subsidiary questions are: Should recruiting operations be centralized in large recruiting substations (RSS) or decentralized in more numerous permanent contact stations? Do transient recruiting facilities (TRF) significantly enhance productivity? What is each recruiting station's proper allocation of facilities and recruiters? How do we best determine the criticality of urban and suburban facilities?

E. SCOPE, LIMITATIONS AND ASSUMPTIONS

The thrust of the study is to develop an econometric model that determines which existing recruiting facilities are most and least critical in maximizing productivity (contracts/recruiter). The area considered is the 12th Marine Corps District, headquartered at Treasure Island Naval Station, San Francisco, Ca., and includes ten western states, California, Arizona, Oregon, Washington, Nevada, Utah, Idaho, Montana, Hawaii and Alaska. This area consists of approximately 301 counties - about 10% of the counties in the United States. The 12th district has 247 recruiting facilities including 98 recruiting substations, 106 permanent contact stations and 43 transient recruiting facilities.

Determining an optimal method of recruiting in the quality market using existing facilities requires knowledge of the geographic size and enlistable population in each facility's area. Propensity weighted Qualified Military Available (PQMA) is the source for determining the location of the quality market. Accepted by the Marine Corps and based on the Center for Naval Analysis study of April 1990, PQMA is the product of enlistment propensity (P) and Qualified Military Available (QMA) [Ref 4].

Given the current recruiting environment of reduced budgets and smaller accession goals, any facility allocation model developed will not propose the establishment of new facilities. A prudent "make the best with what you have" approach has been sought.

Many facilities are joint service facilities which include two or more services in separate offices in the same building. This policy was developed as a cost saving initiative and usually viewed as advantageous to all service recruiters. Multi service facilities are not considered differently from single service facilities since the value of colocation with other services is not clear. Moreover, deciding which facilities are most critical to the Marine Corps does not depend on other service facility location priorities. This study has obvious adaptability to the other five districts of the Marine Corps Recruiting Service.

F. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

A large amount of research on resource allocation and optimal facility planning exists in the operations research [Ref 5,6] and industrial engineering literature [Ref 7,8]. Facility location problems that determine where facilities will be located and the customers they will serve are referred to as location-allocation problems [Ref 5,6,7,8]. In "Facilities Planning" [Ref 7], Tompkins specifies a number of formulations to determine an optimal facility location plan. The formulations tend to minimize cost per unit time. For allocating recruiters, this problem could be formulated to minimize recruiters or distance to the market.

Frances in "Facility Layout and Location" [Ref 8] introduces "Efroymson and Ray" [Ref 9] formulations which minimize the cost of satisfying customer demand. This formulation is solved using branch and bound techniques. Additionally, Frances introduces total cover problems which minimize the plant locations required to cover an entire area. Problems of this type include locating emergency services locations

like firehouses considered by Schrage [Ref 5]. Since the recruiting facility location problem introduces no new facilities, total coverage may not be possible nor even desirable. Francis also considers the partial cover problem which maximizes the number of customers covered. The partial cover formulation is also considered in the "Ohio Banking" problem [Ref 10] which maximizes the number of areas covered by bank branch locations.

Literature on measuring the strength of the recruiting market was found in an April 1990 report developed by the Center for Naval Analysis [Ref 4]. The measurement method referred to as Propensity weighted Qualified Military Available, PQMA, reliably estimates market size and uses input from past all service accessions data. This study relies on PQMA as the source for determining market size. It works well for the Marine Corps due to the Corps' relative small share of the total recruiting market and other services' market saturation.

A Cobb-Douglas production function [Ref 11], found in the economics literature, is a convenient and reliable function to relate PQMA and number of recruiters to Marine accessions. Many production functions including Ralston's Coast Guard model [Ref 12] and Naval Personnel Research and Development Center's (NPRDC) navy production model [Ref 13] employ a Cobb-Douglas production function to model accessions. These models are generally acceptable because they account for marginal returns to scale and are globally optimal when equality exists among the marginal products of the observations.

To properly model Marine accessions, county recruiting data for the Marine Corps and all other services are available in the Market Share Report [Ref 14]. Propensity weighted Qualified Military Available (PQMA) is based on all service accessions results and measures the number of enlistable individuals. Other methods have been used to determine the size of the recruiting market including the Qualified Military Available (QMA) model and more recently the Random Access Model (RAM) [Ref 13] developed by NPRDC. These models generally rely on such factors as unemployment, mail out response rates, advertising and attitude surveys. Their advantage over PQMA is that input is more current and less affected by the present location of the recruiting force. Conversely, most of the indicators are also lagged, and, as a result, the models are more difficult to manage and many of the factors are less reliable and difficult to obtain at the county level and below.

Discrete plant location problems such as the Efroymson and Ray formulations and the Ohio Banking System coverage problem are adaptable to recruiting facility location problems. Mixed integer programming using the General Algebraic Modeling System (GAMS) is effectively used to solve discreet plant location problems.

G. BACKGROUND

Changing demographics and enlistment standards have decreased the effectiveness of recruiting facilities to assist recruiters in meeting enlistment goals. In recent years, California has experienced unparalleled growth especially in areas outside the major population centers while less populous states have experienced

population decline and migration to the city [Ref 15]. Moreover, the increased demand for high quality enlistments over the last ten years has shifted emphasis on the recruiting market from urban to suburban areas. The serious and significant decline in the quality of urban high schools combined with a myriad of other social problems has affected the ability to recruit in these traditionally fertile manpower markets. In the past, the proliferation of facilities tended to lessen the effects of demographic shifts and changes in enlistment standards. Presently, it is necessary to assess facilities more discerningly since operating budgets demand facility reductions. Consequently, a system, efficient and responsive to recruiter needs, should be developed to allocate offices and determine a facility's relative worth.

Historically, locating facilities was a subjective process based on vague and sometimes conflicting criteria. It was adequate to operate in mainly large urban population centers where it was reasonably assumed the largest market of enlistable individuals existed. Los Angeles County, for example, has 31 facilities, significantly more than any other county in the district.

To develop a method of locating recruiting offices, one must understand the definition of a "quality" market. Quality, although a vague term in general use, has very specific meaning in the context of Marine Corps enlistments. A quality enlistment is a high school graduate classified as category I, II or IIIA on the Armed Services Vocational Aptitude Battery (ASVAB) or the Armed Forces Qualification Test (AFQT). The Marine Corps generally recruits from a mental aptitude category I-IIIB pool of non prior service, high school graduates or soon-to-be high school

graduates. Policy in recent years has been to strive for 70% category I-IIIA enlistments and 98% high school graduates. Figures 1.1 and 1.2 dramatically detail the shift towards the quality market. Since these potential enlistees have more options than their less successful peers e.g., college, employment opportunity and competition from other services, they represent a limited supply. Moreover, it is estimated that 50% of the mental category IIIB testers eventually join the service making them a much less limited supply. It is evident that to meet present demand for more talented individuals, the location of facilities must be oriented toward the quality market.

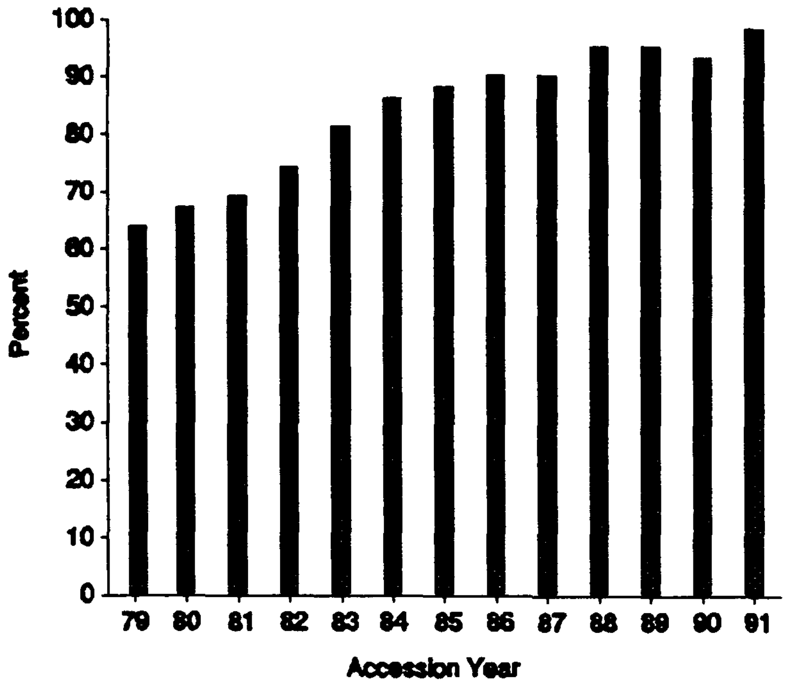

Figure 1.1 H.S. Graduates As A Proportion Of USMC Accessions

In 1990, a method of analysis for locating enlistment eligible individuals possessing a desire to enlist was accepted by the Marine Corps. Propensity weighted Qualified Military Available, PQMA, is an estimation of the number of individuals qualified and likely to enlist. It is based on all service accessions data from two fiscal years prior and has proven to be a better predictor of enlistments for the Marine Corps than the traditional Qualified Military Available (QMA) statistics.

Propensity weighted Qualified Military Available has been successfully used to track potential accessions at the county level. This measurement tool can be criticized because it does not estimate propensity to enlist in the Marine Corps, is less reliable as a measurement tool in rural areas and is substantially influenced by

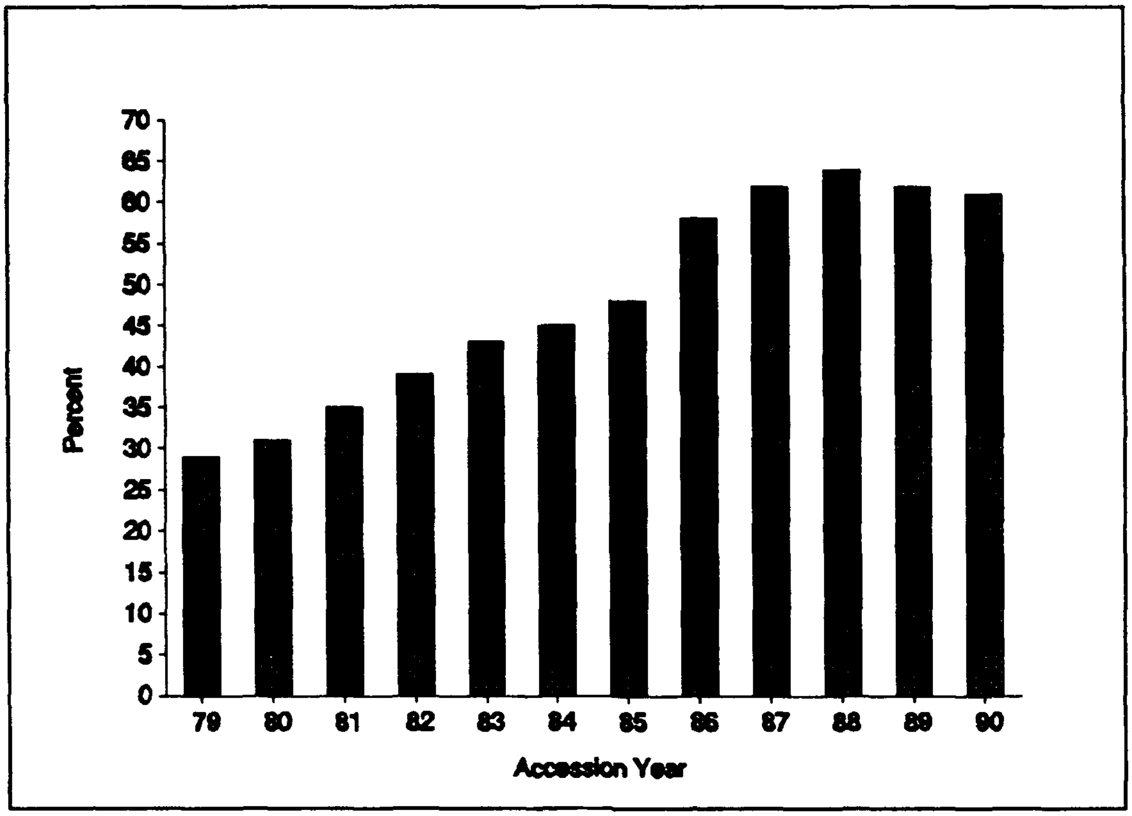

Figure 1.2 AFQT I-IIIA H.S. Graduates As A Percentage Of Total Recruits

the location of recruiters. Although the system has some drawbacks, it is proven to be an accurate tool in determining where the quality enlistment market exists.

II. METHODOLOGY

A. INTRODUCTION

The problem is to determine which recruiting facilities are most critical in supporting the recruiting mission based on various total facility constraints. Facility's act as aggregation points for one or more canvassing recruiters allowing the recruiter access to the recruiting market. The approach is to develop a model to predict Marine accessions as a function of PQMA and recruiters, to distribute the recruiting force optimally, and then to determine an optimal recruiting office reduction plan.

B. DATA COLLECTION

The Marine Corps continually strives to attract quality enlistments. Competition for quality accessions is much keener due to civilian employment opportunities, other service competition and college recruitment. Data collection is generally directed towards locating individuals who are high school graduates or high school seniors, male, 17-21 years of age, non prior service and in aptitude category I-IIIA. The Marine Corps most actively recruits in this market because 17-21 year olds are easier to reach and train, have fewer dependents and moral disqualifiers, and are often seeking first real employment as compared to older enlistable individuals. As a manpower intensive, infantry oriented force subject to the combat exclusion law which disallows females in combat arms occupational specialties, the recruiting effort is overwhelmingly directed at the male market. The high percentage

of category I-IIIA accessions recruited in recent years (Figure 1.2) requires a much greater proportional share of the recruiting effort than the lower aptitude applicants. It is assumed that locating recruiters in facilities to maximize the number of quality enlistments does not substantially reduce the availability of the "demand limited" [Ref 14] mental category IIIB and below applicants. Consequently, accessions data contained in the "Marine Corps Market Share Report" [Ref 1] and used as a basis for analysis are category I-IIIA accessions enlisted during fiscal year 1990.

Each recruiting facility functions as a base of operations for recruiting activities in a certain geographic area. These areas do not overlap other facilities' areas and are manned at levels that should provide relatively equal market share to each canvassing recruiter. A market is a geographical area containing a number of qualified, mental category I-IIIA potential enlistees expressed as PQMA. This measure of the market is based on past all-service accessions normally two years prior to the current year [Ref 4]. In this case, PQMA is drawn from fiscal year 1988, mental category I-IIIA accession results.

Individual service and total force accessions data are available at the county level. Since recruiters conduct most of their prospecting activity close to their base of operations, accessions within the county are assigned to facilities within the county. The assumption is reasonable since supervisors normally delineate recruiting areas along county lines for better coordination and control. Conducting recruiting activity from an outside county in a county that has facilities occurs infrequently and results in relatively few accessions.

Facility manning levels are reported periodically to the 12th District Headquarters and are not completely stable as the numbers vary slightly due to normal recruiter turnover, relief for cause and recruiter relocation. The attempt is to determine the traditional manning levels of all facilities and subjectively consider any large variance in the number of recruiters assigned to a facility during the period that the accessions for that facility were recorded.

C. REGRESSION MODEL

Recruiting facilities are viewed as aggregation nodes where recruiting activities are centered. To determine the optimal location of these nodes, each should hold an optimal number of recruiters.

To obtain maximum productivity from the recruiting force, recruiters should be located where recruiting activity will yield the best results for the least effort. Best results means obtaining the highest percentage of quality accessions while meeting total force recruiting goals. Since 65-70% of the recruiting goal is oriented towards quality accessions and the proportion of recruiting effort expended tapping this market is likely to be much higher than 70%, the recruiter allocation model is directed towards the quality market.

Much research has been completed on determining what factors affect recruiter productivity. Rolston, in his thesis, uses Navy accessions and number of recruiters in each area as his explanatory variables in determining future Coast Guard accessions [Ref 12]. Lewis, in his thesis, takes a different track by explaining the influence of a multitude of explanatory variables on category I-IIIA accessions using

a fixed effects regression model [Ref 16]. Key variables include the number of recruiters assigned, unemployment, military pay and population density. Past methods in determining the Qualified Military Available (QMA) [Ref 4] included many of these same explanatory variables. For large geographic areas these methods are employed with relative success. They are often used to predict accessions at the Army Brigade, Navy and Coast Guard District and Marine Corps Station level, areas which generally include a large number of counties. The explanatory variables used to predict accessions in other recruiter assignment models become less reliable and more difficult to obtain at county level and below. As an example, one survey used to track service propensity is the Youth Attitude Tracking Survey (YATS) which tracks attitudes towards the military in telephone surveys. Although this method is successful on a national or regional basis, its sample size of 10,000 averages about three per county [Ref 4].

To predict the number of quality accessions at the county level, it is necessary to estimate accurately the number of potential enlistees having a propensity towards Marine Corps service and the effort required to attract them. Recent research by the Center for Naval Analysis reveals that the best predictor for the Marine Corps of future accessions is past accessions [Ref 4]. Past accessions form the basis for the development of PQMA and identify the number of enlistable individuals per county. The effort expended recruiting is modelled as a function of the number of recruiters prospecting within the county.

A recruiting production model of the form:

$$Y_i = \beta_0 + \sum_{j=1}^{n} \beta_j X_j + e_i \tag{2.1}$$

is developed where

Y_i = number of Marine accessions in area i

X_j = j^{th} supply production variable

β_j = regression coefficient of j^{th} supply production variable, j = 1,...,n

ϵ_i = regression error in area i

n = number of production variables.

This ordinary least squares multiple regression model assumes the residuals, u, are random quantities, independent, normally distributed with mean zero and constant variance [Ref 17]. In this model the two supply production variables (n = 2) are PQMA and number of recruiters.

Rolston and the Navy Personnel Research and Development Center (NPRDC) developed similar recruiting production models accounting for existing heteroskedasticity in the model. By transforming the Ordinary Least Squares (OLS) function, an equation of the form:

$$Y_i = k_i \prod_{j=1}^{n} X_{ij}^{\beta_j} \tag{2.2}$$

where k_i = scaling constant for county i

Y_i = Marine accessions in county i

X_{ij} = j^{th} production variable in county i, j= 1,...,n

β_j = regression coefficient of the j^{th} supply production variable, j = 1,...,n

n = total number of production variables

was developed. This production model has several advantages over the OLS model. The transformed homoskedastic data have reduced variance which yields a more precise estimate of Marine accessions and the marginal effect of the production variables is introduced in the transformed function. The basic OLS model lacks credibility in this situation since increasing any of the two resources (PQMA and recruiters) would not yield constant linear increases in productivity. If the regression coefficient is less than one, a likely case, Equation 2.2 will be a concave function and yield decreasing returns to scale. This means the output (Marine accessions) will increase by a smaller proportion than the increase in inputs (production variables). As additional recruiters are added, the average productivity of the recruiters decreases.

D. RECRUITER ALLOCATION

The objective in allocating the recruiting force is to maximize productivity. It is assumed that recruiters are not presently assigned to locations that maximize recruiting potential. To accomplish an optimal allocation, the recruiter production function, Equation 2.2, is maximized over all counties. Rolston and NPRDC use two different approaches to solve an equation of the form of Equation 2.2. Rolston uses dynamic programming methods while NPRDC attempts a nonlinear mixed integer

programming approach with the General Algebraic Modeling System (GAMS). The multiplicative model used by NPRDC [Ref 13] is of the form:

$$MAX \sum_{i=1}^{n} a_i \, R_i^{\alpha} \tag{2.3}$$

$$s.t. \sum_{i=1}^{n} R_i \le TR$$

$$\underline{TRA}_i \le R_i \le \overline{TRA}_i, \; for\ all\ i$$

$$\underline{PR}_i \le \sum_{i=1}^{n} a_i R_i^{\alpha-1} \le \overline{PR}_i \quad for\ all\ i$$

where a_i = production function for county i

R_i = number of recruiters in county i

TR = total number of recruiters

TRA_i = upper and lower bound on total number of recruiters in county i

PR_i = upper and lower bound on recruiter productivity in county i.

The nonlinear mixed integer programming approach is time consuming and does not ensure an optimal result while the dynamic programming model is less intuitive and unwieldy for the size of the data set.

Equation 2.3 is of the form of a Cobb-Douglas function. If second order conditions do not exist in the unbounded, continuous solution, the equation is maximized when the marginal values are equal and of the form [Ref 18]:

$$\frac{\partial \sum_{i=1}^{T} P_i R_i^{\alpha}}{\partial R_1} = \frac{\partial \sum_{i=1}^{T} P_i R_i^{\alpha}}{\partial R_2} = \ldots = \frac{\partial \sum_{i=1}^{T} P_i R_i^{\alpha}}{\partial R_T} \tag{2.4}$$

where t = total number of counties

P_i = PQMA in county i

R_i = number of recruiters in county i

α = regression coefficient

which is equivalent to:

$$\frac{\alpha P_1}{R_1^{1-\alpha}} = \frac{\alpha P_2}{R_2^{1-\alpha}} = \frac{\alpha P_3}{R_3^{1-\alpha}} = \ldots = \frac{\alpha P_T}{R_T^{1-\alpha}} \tag{2.5}$$

Equation 2.5 makes intuitive sense since meeting the equality constraints to ensure optimality requires assignment of more recruiters to the areas with higher PQMA. The difficulty with this solution applied to recruiter assignments is that it does not provide an integer solution or allow any area to be without recruiters (R = 0 is undefined).

The application of Equation 2.5 to the recruiter assignment model requires a heuristic algorithm to ensure optimality, allow an integer solution and account for the situation where an optimal integer solution includes areas with no recruiters. This algorithm is developed in the following steps:

1. Rank areas by PQMA from highest to lowest.

2. Assign the first recruiter to the county with maximum PQMA.

3. Assign additional recruiters to area with maximum P_i until

$$\frac{\alpha P_{max}}{R_{max}^{1-\alpha}} \leq \alpha P_{max-1} \quad \textit{or } R_{max} = \max \textit{ recruiters in facility i.} \tag{2.6}$$

4. Assign recruiters to R_{max-1} and back to R_{max}, if the sign of the inequality is reversed, until

$$\frac{\alpha P_{max}}{R_{max}^{1-\alpha}} \leq \frac{\alpha P_{max-1}}{R_{max-1}^{1-\alpha}} \leq \frac{\alpha P_{max-2}}{R_{max-2}^{1-\alpha}}. \tag{2.7}$$

5. Assign recruiters to P_{max-2}/R_{max-2} until

$$\frac{\alpha P_{max-1}}{R_{max-1}^{1-\alpha}} \leq \frac{\alpha P_{max-2}}{R_{max-2}^{1-\alpha}} \leq \frac{\alpha P_{max-3}}{R_{max-3}^{1-\alpha}} \quad \textit{as with steps } 2 \textit{ and } 3. \tag{2.8}$$

6. Continue the sequence until the total number of recruiters available is exhausted.

This "greedy" model can be programmed in FORTRAN 77, has reduced run time and allows recruiters to be sequentially added to areas that produce the highest return (most Marine accessions).

E. FACILITY ALLOCATION

The recruiting facility is the hub or "aggregation node" for all recruiting activity in an area. To obtain the best return on recruiting activity, the market must be as accessible as possible from the facility. An area's value to the recruiting effort is

measured by the number of qualified, aptitude category I-IIIA individuals having some interest in military service. The area's market strength is measured by PQMA.

A facility's importance is also measured by its ability to support recruiting activity in counties without facilities and areas with unneeded offices. A facility may have a relatively small market in it is primary recruiting area but become substantially more valuable recruiting in an adjacent or, for the sake of clarity, a secondary area. It is feasible that an existing facility could manage recruiting activity for one or more adjacent facilities. Alternatively, a more remote facility might be the only one available to provide recruiter access to a marginally productive area.

Facility allocation is based on three criteria:

1. Utilize only existing facilities.
2. Locate facilities near the market.
3. Provide access to sufficient markets to meet accessions goals.

In deciding which facilities to close, those that least support the criteria are targeted for closure.

Each recruiting office covers a geographic area containing a proportion of the total recruiting market. In counties with one facility, that area is the county and the market is the PQMA for that county. In counties with multiple recruiting offices, the area and PQMA for a particular facility are less clear. Since accession data are only measured at the county level, a method to determine PQMA per facility was established. The method is based on the number of recruiters that traditionally man a particular office compared to the total number of recruiters in the county. If a

facility is one of two or more facilities in a county, the PQMA in that recruiting facility's area is determined by Equation 2.9.

$$P_{ij} = \frac{R_i}{\sum_{i=1}^{n} R_i} \; x \; P_j, \quad for\ all\ i \in j, \quad for\ all\ j \tag{2.9}$$

where R_i = number of recruiters in facility i

P_j = PQMA in county j

P_{ij} = PQMA for facility i in county j

n = total number of facilities in county j.

This method of determining PQMA for a particular facility in a county with more than one facility is reasonable. Each facility has a proportional share of the county market based on its number of recruiters. This procedure works well if each recruiter has a roughly equal share of the PQMA. In other words, a two-man facility is expected to have roughly twice the PQMA of a single recruiter facility. The traditional manning level of facilities within a county is usually developed over years of trial and error in determining what works best. Moreover, most counties have no more than three facilities, with a few large exceptions, making recruiter assignments by the commander within the county manageable and reliable once the total number of recruiters to assign to the county as a whole is determined.

To use the existing facilities best and assist in making decisions on down-scaling the number of facilities, an algorithm is developed which determines a recruiting facility's relative value. A station's value is based directly on the number of qualified

individuals in its part of the county and the number it has access to in adjacent areas of the same county or adjacent counties. Facility reduction is accomplished by targeting for closure those facilities with the lowest values.

The discrete plant location formulation is used to maximize the total population of enlistable individuals reachable from a reduced number of existing facilities. The discrete plant location problem has two variants: the "total covering problem" and the "partial covering problem" [Ref 8]. In the facility location problem, the objective is to provide access to (cover) sufficient markets to meet accession goals. These markets produce enough accessions to make the recruiting effort in that area worthwhile. It is neither reasonable nor probably even possible to use a total covering algorithm [Ref 5] similar to those used to locate emergency services, to cover all counties. Some counties produce a negligible number of accessions and attempting to cover these counties would be a waste of recruiter resources. Also, the modelling assumption does not allow any new facilities which may mean that coverage of all areas is impossible. The partial covering algorithm lends the flexibility to maximize the size of the market served while not being constrained to provide recruiters to non-productive areas. To maximize the total population served, facilities are allocated according to the following formulation:

$$Z = MAX \sum_{i} X(I)\ PFAC_i + Y(I)\ PFAC_j\ C \qquad (2.10)$$

$$s.t. \sum_{j} ADJ(I,J)\ X(J) \geq Y(I) \quad \textit{for each } i$$

$$\sum_{i} X(I) \leq NSTA$$

$$X(I) + Y(I) \leq 1 \quad \textit{for each } i$$

where

NSTA = total number recruiting facilities

X(I) = a binary variable; one (1) indicates a facility is located in area i and zero (0) indicates no facility is located in area i

Y(I) = a binary variable; one (1) indicates area i is recruited from an adjacent area and zero (0) indicates area i is not recruited from an adjacent area

ADJ(I,J) = a binary variable; one (1) if Y is adjacent to X and zero (0) if not adjacent

$PFAC_j$ = PQMA per facility in area j.

C = Penalty for recruiting out of area (C = 0.3)

The adjacency matrix details those areas that are "recruitable" from an area with an existing facility. An area is "recruitable" if recruiters, located in an area with an existing facility, have relatively easy access to an area nearby. This generally means the recruiting office is within about 60 minutes travel time of the other area's major population center. Except in a few cases, the area with the recruiting office, called the primary recruiting area, is physically bordered by the adjacent areas. In instances

where this is not the case, areas that do not geographically border the primary area are so close that it is clearly viable to conduct recruiting activity from the primary area.

F. FACILITY SIZE

When determining an optimal mix of recruiting facilities, it is reasonable to consider productivity differences in recruiting stations as a result of the manning level. A consensus has never developed on the number of recruiters to assign to an office that would maximize productivity. The most beneficial facility size is surely based on a myriad of factors including personality and style of both recruiter and supervisor, experience, regional differences and the group dynamics of those working in a particular office. Though these elements are difficult to quantify, some quantitative comparison could assist the commander in his or her assignment policy.

Analysis is conducted to detect any productivity differences among one, two and three or more recruiter facilities. A facility with three or more recruiters is considered a multi-man facility. To remove as much interaction effect as possible, research is conducted only on those facilities in counties having no other facilities with different manning levels. In other words, if a county has a one and two recruiter facility, the productivity of the one recruiter facility is not independent of the productivity of the two recruiter facility. Analysis of Variance is used to test for any statistical differences in productivity among types of facilities. For ANOVA testing, one adopts the assumption that the country recruiter productivities are independent normal random variables, each with its own mean, u, and common

variance σ^2. This assumption is supported by the bell-shapped appearance of the histogram. The hypothesis test is of the form:

$$H_0\colon \mu_1 = \mu_2 = \mu_3 \qquad (2.11)$$

H_a: *any two are not equal*

$$s^2 = \frac{1}{n-1} \sum_{i=1}^{n} (y_i - \bar{y})^2 \qquad (2.12)$$

with the test statistic:

$$T = \frac{\bar{Y} - \mu_0}{s/\sqrt{n}} \qquad (2.13)$$

where

μ_i = mean productivity per recruiter in one, two and three or more recruiter facilities

Y = average productivity

T = test statistic

s = standard deviation

n = number of facilities (n = 34).

The null hypothesis is rejected if the test statistic is greater than $t(\alpha = .9)$. If the null hypothesis is rejected, the conclusion is that evidence suggests that facility size affects productivity.

III. PRESENTATION OF DATA COLLECTED

A. DEMOGRAPHICS

The recruiting force is a matrix style organization where a clear hierarchy of responsibility exists. In a matrix style organization lines of authority are explicitly delineated from the top to bottom level. This type of organization reflects most operational military commands. The 12th District, one of six recruiting districts, is organized according to Figure 3.1. The district is responsible for nine recruiting

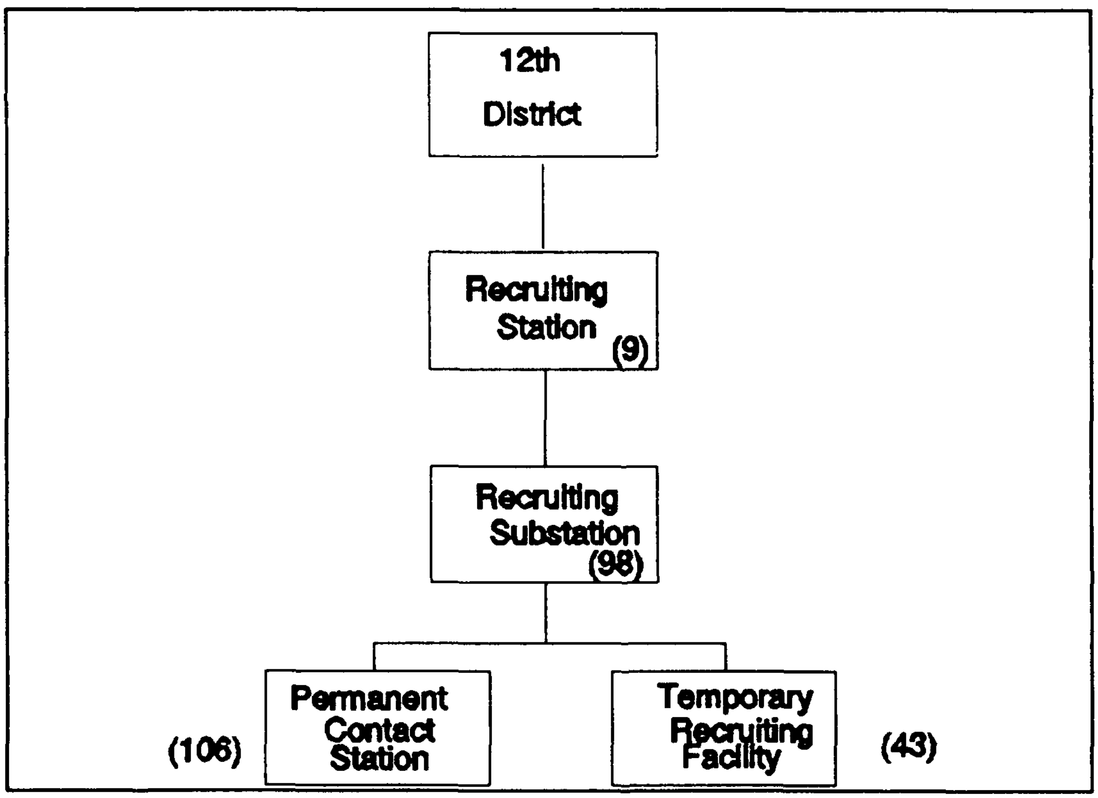

Figure 3.1 12th District Organizational Chart

stations, each commanded by a Major. The boundaries of these nine recruiting stations are clearly defined and exhibited in Figure 3.2. These boundaries are set by state and county lines to ensure that the recruiting efforts do not overlap.The nine recruiting stations conduct recruiting activity through 98 recruiting substations each having a noncommissioned officer-in-charge (NCOIC) responsible to the recruiting station commanding officer. The recruiting substation NCOIC is responsible for directing the recruiting effort in all or part of a county or multiple counties. To assist the NCOIC in canvassing the entire area of responsibility, permanent contact stations and temporary recruiting facilities are established. The 12th District has 106

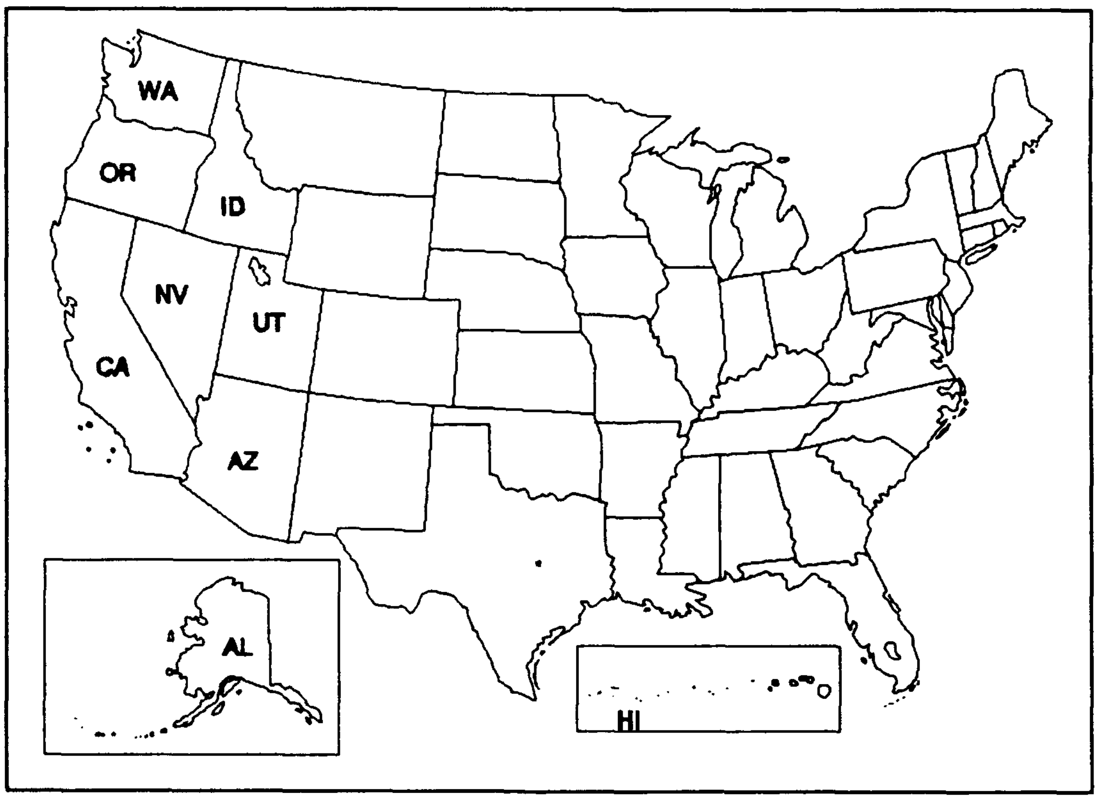

Figure 3.2 12th Marine Corps District

permanent contact stations. The permanent contact station having one or more permanently assigned recruiters, provides access to markets that are large enough to support the recruiters in their prospecting efforts. The transient recruiting facility is a part time office located in less populated areas and is used fewer than five days per week [Ref 21]. The 12th District maintains 43 such facilities, all in rural locations.

The area of the 12th District includes ten states and approximately 301 counties. In fiscal year 1990, the district produced 3,952 aptitude category I-IIIA accessions by approximately 395 recruiters. The number of Marine Corps quality accessions represented 16.7% of the quality accessions from all services.

Propensity weighted Qualified Military Available (PQMA) measures the size of the market in each county. Based on past all service quality accessions, PQMA is a more reliable predictor of the number of individuals interested and qualified for military service than QMA [Ref 22] . The PQMA available to recruiters in each county is listed in Table 1 (Table 1 follows Appendix E). The number of service accessions range from zero in some non-productive counties to over 1700 in the most productive county in the district, Maricopa County, Arizona. Figure 3.3 shows a reliable relationship ($R^2 = .95$ and $F_{.05} = 19$) in each county between Fiscal Year 1988 PQMA and Marine accessions in Fiscal Year 1990.

Adjacent areas are those not in a facility's primary recruiting area but that can be canvassed by recruiters from that facility without significant difficulty. An area

is considered adjacent to a neighboring facility if the area's largest population center is within roughly one hour's travel time.

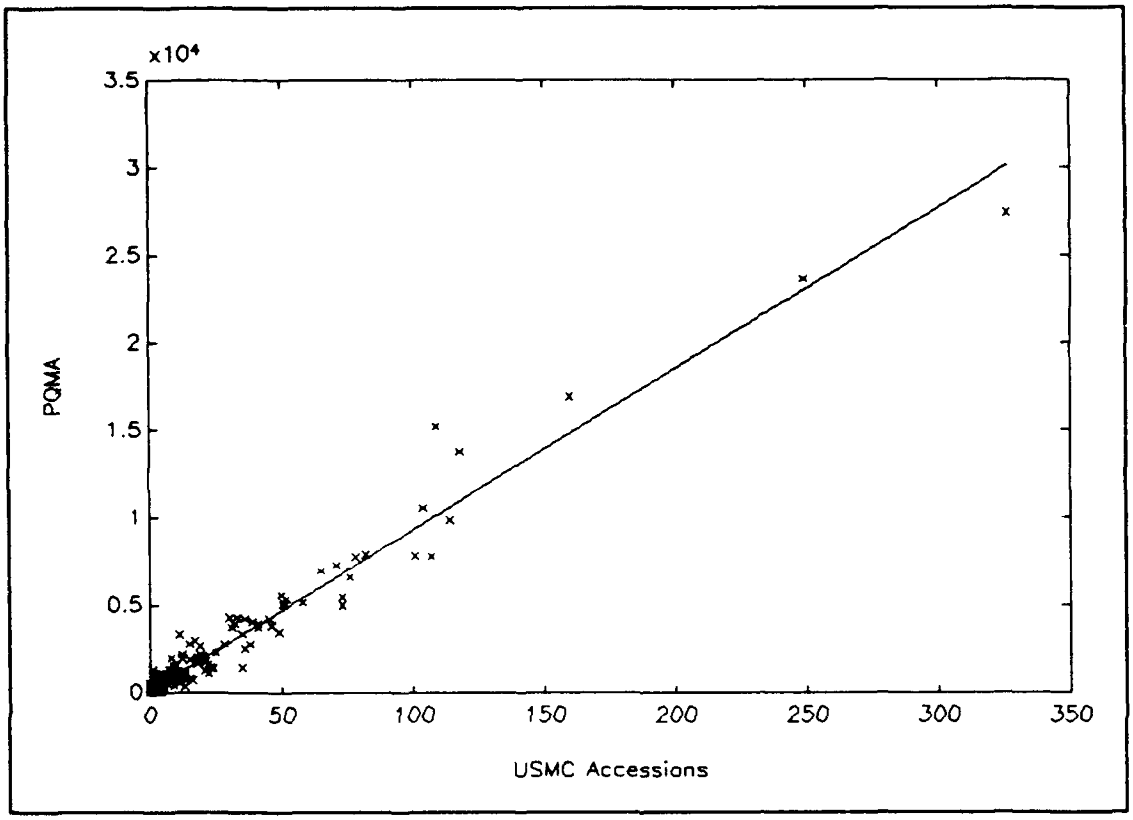

Figure 3.3 PQMA vs USMC Accessions

Adjacent areas were determined from inspection of the Rand Atlas [Ref 23] and listed in the facility allocation program in Appendix D. A facility with easy access to a sizable adjacent recruiting market could reduce the necessity for the facility located in that adjacent area.

B. RECRUITERS

The 12th District has a manning level of 419 recruiters. A recruiter is defined as an enlisted Marine from the rank of Sergeant to Master Sergeant who conducts

or is directly responsible for conducting recruiting activities. Recruiters are assigned a monthly quota which normally requires a minimum of two accessions per month.

The recruiting force in the 12th District is concentrated in areas intended to maximize productivity. Currently, 248 of the 395 recruiters are assigned to the 20 largest counties. Almost 63% of the recruiting force is located in less than 7% of the counties. Interestingly, 209 counties or 64% have no permanently assigned recruiters. The county with the largest number of recruiters is Los Angeles County with 55, followed by Maricopa County, Arizona with 26 and San Diego County, Ca., with 24 recruiters. The number of recruiters in each county is listed in Table 1, column 7. To ensure recruiters have the best possible recruiting environment, they should be located near the quality market. Figure 3.4 details the relationship between the number of Marine accessions and recruiters in the market. Each data point represents the Fiscal Year 1990 category I-IIIA accessions and recruiters in each county. A strong relationship between PQMA and number of recruiters ($R^2=.89, F_{.05}=19.1$) also exists and reflects the ability of recruiting supervisors to assign recruiters effectively to counties with the largest market of highly qualified individuals. Los Angeles County is clearly an outlier when plotted in Figures 3.3 and 3.4 and has been removed from the data set used in both figures.

C. FACILITIES

A recruiting facility : a recruiting substation, permanent contact station or transient recruiting facility. In the 12th District, 186 counties have no facilities while

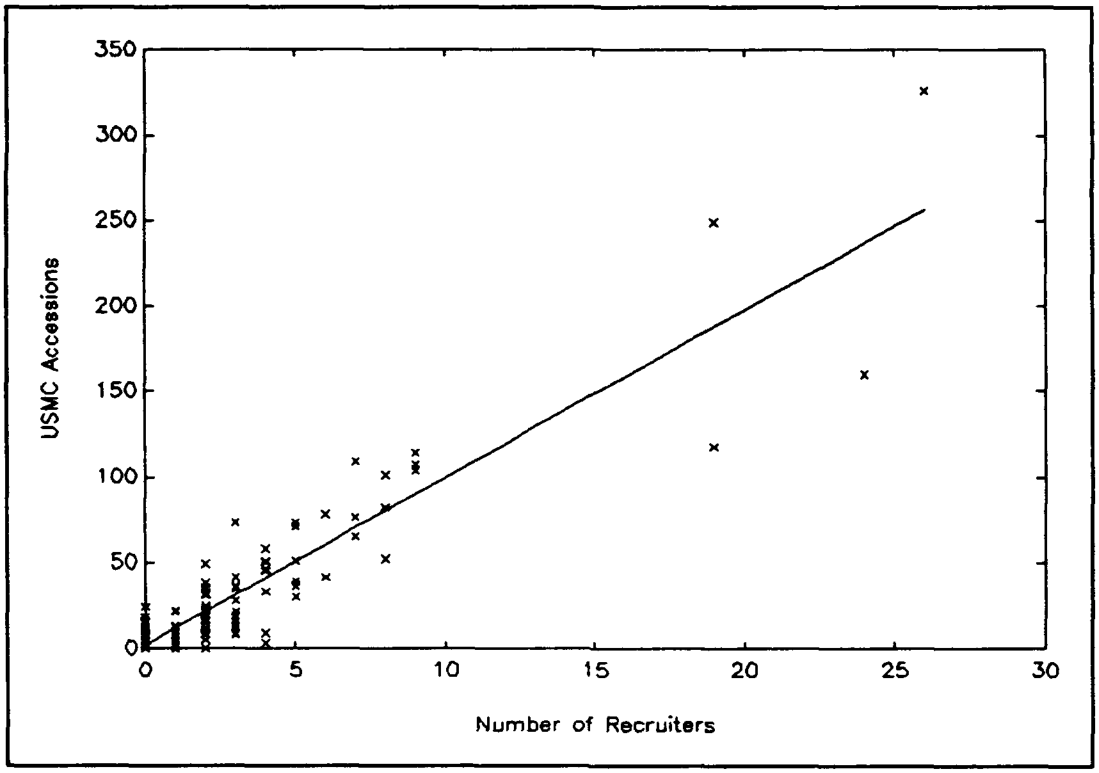

Figure 3.4 USMC Accessions vs Recruiters

Los Angeles County has the most with 31 followed by Maricopa County with 9 facilities. A recruiting facility generally houses from one to five recruiters.

In the district, 25 counties have only one office with a single recruiter; 11 counties have only one office with two recruiters; and 12 counties have only one multi-recruiter (three or more) office. These data are important in analyzing whether the number of recruiters assigned to a facility affects individual recruiter productivity.

The purpose of a recruiting office is to provide a location where a recruiter can maximize his or her effort in attracting quality accessions. An indicator of the value of recruiting offices in a particular county is the mean productivity per facility. If a county has very low productivity per facility, it might suggest that the county has

more than its share of facilities. Since assigning recruiters is a more dynamic process than relocating facilities, it is most likely that large differences in productivity per facility are caused by recruiters realigned in new areas while facilities remained in the same locations. Certainly, other factors such as the geographical size of the county and the accessibility of an area from other parts of the county need to be considered. Since recruiting offices only exist to assist recruiters in accomplishing their recruiting mission, it is legitimate to question the need for excess facilities where productivity is insufficient. Currently, almost 50% of the recruiting offices are located in the 20 largest counties. Reducing facilities in these 20 counties would probably have a smaller marginal effect than in other counties with many fewer offices. Figure 3.5 details the Category I-IIIA productivity per facility in the 20 largest counties. A large disparity in productivity per facility is immediately apparent as Clark County, Wa., produced about 40 accessions per facility while Los Angeles County produced less than four accessions per facility. These statistics are not adjusted for the number of recruiters in each facility. A facility with a large number of recruiters assigned is usually more valuable than a single recruiter facility. Therefore, the gross production of each facility is a possible indicator of locations where the area is no longer productive but the facility remains. Part of this disparity is recognized as the reliance in some counties on smaller and more numerous recruiting facilities with fewer recruiters.

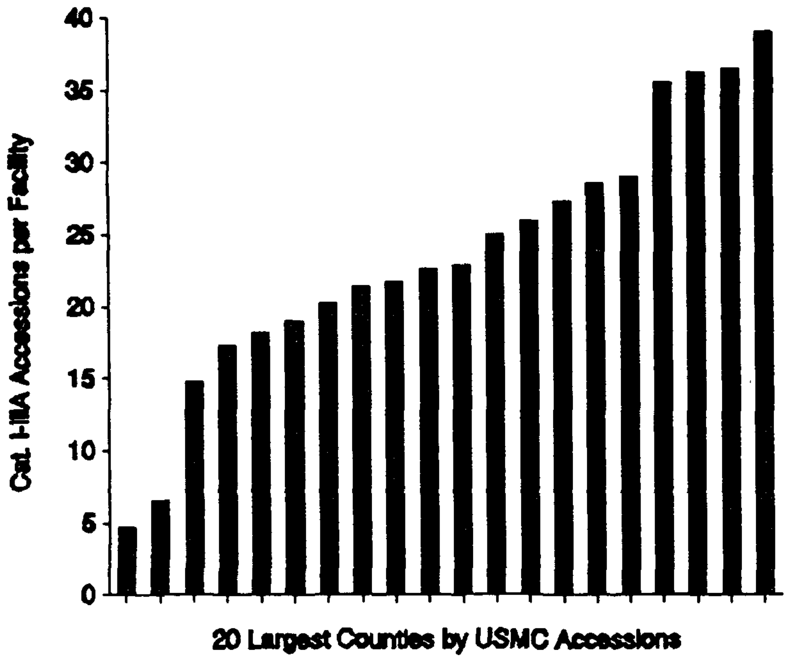

Figure 3.5 Category I-IIIA Productivity per Facility

D. ACCESSIONS

Accessions can be grouped into three general types for the purpose of analysis. Quality accessions are high school graduates scoring in aptitude categories I-IIIA on the Armed Forces Qualification Test and account for nearly 70% of Marine accessions. The second group contains Category IIIB enlistees who account for most of the remaining enlistments. Finally, the third group contains the category four enlistees who are generally unqualified for enlistment except in very special

circumstances. As service end strength shrinks, it is expected that the relative demand for quality accessions will increase.

In fiscal year 1990, the district enlisted 3,952 category I-IIIA individuals. Overall, 54% of the enlistees were accessed from the 20 largest counties. In fact, only 26 counties produced more than 45 accessions indicating that 62.3% of those enlisted came from 8.6% of the counties.

The size of a recruiting office is based on the number of full time recruiters manning it. The mean number of accessions in different size recruiting facilities was investigated to detect any productivity differences among the one recruiter, two recruiter and multi-recruiter offices. The mean productivity per recruiter for a one recruiter office was 7.7, for a two recruiter office it was 12.0, and for the multi-recruiter office it was 7.2. Using analysis of variance these mean productivity measures can be analyzed to determine if any significant difference exists among recruiting facilities of different sizes.

IV. DATA ANALYSIS AND INTERPRETATION

A. INTRODUCTION

A production function to model Marine accessions was developed using linear regression. The recruiters are allocated using a capacitated, nonlinear optimization program and a heuristic algorithm to obtain a distribution of recruiters by county. Recruiting facilities were allocated by maximizing PQMA and based on the constraints placed on the maximum allowable number of facilities. Facility costs were assumed to be constant. Facility size was examined to determine the best individual office manning level and a consideration of the value and necessity of transient recruiting facilities was made.

B. PRODUCTION FUNCTION

The objective of creating a production model was to predict the number of Marine category I-IIIA accessions. Fiscal year 1990 Marine accessions were modeled as the dependent variable and PQMA and the number of recruiters were the explanatory variables. The best fit was a logarithmic function of the form:

$$Y = P^{0.489} R^{0.628} \tag{4.1}$$

where

Y = number of Marine accessions

P = PQMA

R = number of recruiters.

The production function is nonlinear

$$[R^2 = .95;\ t_{.95} = 6.6,\ 20.8].$$

The high R^2 and satisfactory individual t-scores (6.6 for recruiters and 20.8 for PQMA) suggest each explanatory variable is significant in modelling Marine accessions. Moreover, a strong positive relationship exists between Marine accessions and the explanatory variables and both PQMA and number of recruiters are logically justifiable as explanatory variables in the production function. As recruiters are added to a county the marginal return (number of accessions) from adding each additional recruiter diminishes. This model was developed from the 86 counties that have recruiters and produce about 88% of the enlistments.

Although some correlation exists between the independent variables, multicollinearity does not appear to be severe. The high R^2 value combined with the high individual t-scores and satisfactory F-scores ($F^*(.95;2,83) = MSR/MSE = 24.9$ compared to $F(.95;2,83) = 3.1$) indicate the lack of severe multicollinearity.

Moreover, the coefficient value of either explanatory variable shows little change if an intercept value is added and the other variable is removed [Ref 24].

Although a number of different explanatory variables are used in other recruiter production functions, at the county level, recruiters and PQMA are the most reliable. Bias in the model from the omission of relevant independent variables is not indicated. Recruiters and PQMA aptly describe recruiter production at the county level, significant unexpected signs on the coefficient estimates are not present and the explanatory variables are a good fit.

Counties without recruiters still produce accessions. Fully 211 counties without Marine recruiters produced some all-service accessions. In fiscal year 1990, 452 Marine accessions came from counties without recruiters. In this situation, Marine accessions were modelled linearly against PQMA [R^2 =.76; $t_{.95}$=25] and are of the form:

$$Y = 0.13\ P \tag{4.2}$$

In FY90, the 12th District enlisted 3,952 individuals while the production model predicted 3,814 enlistments with the existing recruiter assignments. The predicted number of accessions is within 4% of the actual number of enlistments. The production model accurately models fiscal year 1990 accessions. The robustness of the model should be tested once fiscal year 1991 accessions data becomes available.

C. RECRUITER ALLOCATION

Using the recruiter production model:

$$Y = MAX \sum_{i=1}^{n} P_i^{.489} R_i^{.628} \tag{4.3}$$

$$s.t. \quad \sum_{i=1}^{n} R_i \leq 419$$

$$\sum_{k \in i} R_k \leq \overline{TRA}_i$$

where

Y = number of Marine accessions

P_i = PQMA in county i

R_i = recruiters in county i

R_k = recruiters in facility k

TRA_i = upper bound on recruiters in county i

n = total number of counties in 12th District,

recruiters were distributed over the 301 counties in the 12th District to maximize Marine accessions. Since the production function is a concave function, the nonlinear solver in GAMS returns an optimal real number solution. Obviously, an integer solution is required since recruiters can not be fractionally assigned to areas.

The distribution of the force is a capacitated, partial covering problem. This means only the counties that guarantee the greatest marginal return receive recruiters and each county has an upper bound on the number of recruiters it can accept. This upper bound is based on the number of facilities and available space in each facility located in the county. The maximum allowable number of recruiters in any county is four per facility. This restriction is developed to allow an allocation of recruiters which is feasible when considering office space limitations. Recruiters can not be added to counties that have reached capacity in all facilities. Pierce County, Washington County and Maricopa County are limited by this constraint.

The nonlinear real valued optimization program in Appendix A does not satisfactorily distribute the force. The heuristic algorithm employed to obtain an integer solution to the recruiter allocation problem is based on maximizing the number of additional accessions produced (marginal product) as each recruiter is added to a county. As a short example of the larger problem, suppose five recruiters are to be distributed over three counties. The PQMA of the three counties are 60, 70, and 80 respectively. The production function is $Y = P^{.49}R^{.63}$ where Y is Marine accessions, P is PQMA and R is the number of recruiters. The nonlinear solution yields:

County	Recruiters
A	1.31
B	1.64
C	2.85

Since the optimal solution requires at least one recruiter in County A, one recruiter in County B and two recruiters in County C, only one additional recruiter needs to be assigned. To decide where the next recruiter should be located, we consider the marginal return of each county when a recruiter is added. The return for each county is:

$$P^{.49}(R+1)^{.63} - P^{.49}(R)^{.63} = \text{Marginal Return}$$

County

A	$(60)^{.49}(2)^{.63} - (60)^{.49}(1)^{.63} = 11.506 - 7.435 = 4.071$
B	$(70)^{.49}(2)^{.63} - (70)^{.49}(1)^{.63} = 12.409 - 8.019 = 4.391$
C	$(80)^{.49}(3)^{.63} - (80)^{.49}(2)^{.63} = 17.104 - 13.248 = 3.856.$

Since County B produces the greatest marginal return when the fifth recruiter is added, assign him or her to County B.

The heuristic for distributing the recruiters was programmed in FORTRAN 77 and displayed in Appendix B. Ten of the 416 recruiters were distributed to counties without facilities. These recruiters were reassigned to adjacent counties. Each recruiter was assigned to the county within the closest proximity. If two or more counties were equidistant, then the recruiter was assigned to the county that produced the greatest marginal return in Marine accessions. The output produced from these programs yields an integer solution to the recruiter allocation problem and is displayed in Table 2 (Table 2 follows Appendix E).

The purpose of the recruiter allocation is to improve the yield of category I-IIIA enlistments without increasing the number of recruiters or facilities. If the

recruiting goal remains the same or is reduced, the new allocation gives the recruiting force a better chance at being successful and perhaps, a less intense recruiting environment. Using the production function developed and the new recruiter allocation plan with fiscal year 1990 accessions, the predicted number of new accessions using the proposed allocation is 4,039. This results in 225 or 5.9% more accessions than actually enlisted under the present recruiter allocation. The implications of these 225 additional aptitude category I-IIIA accessions could be reduced recruiter manning and a higher percentage of quality accessions.

D. FACILITY ALLOCATION

Recruiting facilities should be located in areas where the category I-IIIA enlistment potential is highest. To best determine where the market is located, we rely on past all-service accessions by measuring the PQMA available to each recruiting facility. By maximizing the PQMA available, we can determine the best allocation of facilities. Facility location is based on PQMA rather than pure Marine accessions because PQMA has the following advantages.

1) PQMA has a data base of 24,900 all-service accessions compared to 3,950 Marine accessions.

2) All service accessions, due to the advantages of market saturation, better determine each recruiting market's true potential.

3) PQMA lessens the effects of underproductive or overproductive Marine recruiters in determining the market potential.

4) PQMA identifies productive areas where increased marine recruiting effort should yield more Marine accessions.

The ration of Marine accessions$_i$ / PQMA$_i$ for each county i resembles a normal distribution indicating a robust relationship between the independent variable of Marine accessions and the dependent variable, PQMA, throughout the range of values for PQMA. The disadvantage of basing facility location on PQMA is that it measures all-service enlistment propensity rather than Marine Corps service propensity. This can be overcome by examining all counties to determine if any with facilities targeted for closure produce a substantial number of Marine accessions.

The PQMA for each facility was determined by the product of county PQMA and the percentage of recruiters in the entire county manning a particular facility. As an example, Santa Clara County has ten recruiters with five facilities and a total PQMA of 9,615.

Facility	No. Recruiters	PQMA
1	3	3/10 x 9,615 = 2,885
2	3	3/10 x 9,615 = 2,884
3	2	2/10 x 9,615 = 1,923
4	1	1/10 x 9,615 = 962
5	1	1/10 x 9,615 = 961
Total	10	9,615

The PQMA is maximized based on the constraints placed on the total number of facilities allowed. Although the size of the reduction in recruiting facilities is not yet clear, a 10% initial reduction in total facilities was considered reasonable in view

of recent end strength proposals. Regardless, the model is easily programmed to determine the allocation based on any final reduction policy.

The function maximized is:

$$MAX \sum_{i} X(I)\ AFAC(I)\ +\ \beta\ Y(I)\ AFAC(I) \tag{4.3}$$

$$s.t. \sum_{j} ADJ(I,J)\ X(I)\ \geq\ Y(I)$$

$$\sum_{i} X(I)\ \leq\ 215$$

$$X(I)\ +\ Y(I)\ \leq\ 1\ \ \textit{for each } i$$

where

AFAC(I) = number of all-service accessions from area i

X(I) = a binary variable; one (1) indicates a facilty is located in area i and zero (0) indicates no facilty is located in area i.

Y(I) = a binary variable; one (1) indicates an area i without a facilty is recruited from an adjacent area and zero (0) indicates an area i is not recruited from an adjacent area.

ß = out of area recruiting penalty (ß = 0.3).

ADJ(I,J) = a binary variable, one (1) indicates area i is adjacent to area j and zero (o) indicates area i is not adjacent to area j.

The GAMS program for the facility reduction model is included in Appendix D. The optimization locates the maximum allowable number of facilities yielding the most

PQMA. The value of a facility is based on the PQMA in its area and a portion of the PQMA in adjacent areas. An adjacent area is an area which can be recruited from another area having a recruiting facility. Adjacent areas usually physically border each other and have facilities (the major poulation center if no facility exists) within 60 minutes travel time of each other. A penalty is awarded for out-of-area recruiting since it is less productive and forces the optimization program to locate facilities in the area with the largest PQMA among adjacent facilities. The penalty chosen was 0.3 which is reasonable since only 12-14% of the accessions come from counties without recruiters and only 13% of the all-service accessions in areas without recruiters become Marine accessions. This indicates that recruiters enlist relatively few individuals out of their area.

Facility closures should be a phased, incremental process to allow analysis of the effects of the closures. In this regard, the model developed restricts closures in any one county to no more than twice the overall percentage reduction. This means a district wide reduction in facilities of 10% would result in no greater than a 20% reduction in any single county. Sensitivity analysis indicates that in the unconstrained case, this policy only limits the reduction in facilities in Los Angeles County. A 10% facility reduction would force the closure of approximately 25 recruiting facilities.

The closure of these 25 facilities would have little impact on the allocation of recruiters by county. In fact, optimal allocation of the recruiting force could still be maintained. Facility closures in the 20% range would detrimentally affect the ability to allocate the recruiting force optimally.

The facility reduction plan does not consider any differences in costs for leases and maintenance, which could be substantial, among facilities. Of course, the objective of the study is to maximize productivity and reduce nonproductive facilities. While monetary cost of operation is important, it is not the thrust of this study.

E. FACILITY SIZE

Many factors determine the success or failure of recruiters in the field. Some suggest that recruiters should not be assigned individual quotas. Instead, group goals should be assigned to members of a larger group such as a recruiting substation. Some sales organizations and manufacturers task their employees in this manner. Although assigning only group quotas to Marine recruiters might be considered heresy, group interaction at the substation level is certainly a major element of individual success. The relationship among recruiters in their quest to achieve the substation goals is critical.

Group dynamics are complex and difficult to model. The number of recruiters manning a particular facility affects recruiter productivity and was investigated. The optimal allocation of recruiters requires a substantial number of single recruiter facilities. The productivity (accessions per recruiter) of single recruiter and "two-man" facilities was analyzed to detect any difference in productivity due to the facility manning level. Using analysis of variance methods (ANOVA), production in both types of facilities was compared. The sample only included facilities in counties that have either single recruiter facilities only or two recruiter facilities only. The sample size is 34 facilities including 23 one recruiter facilities and 11 two recruiter facilities.

The ANOVA calculations are presented in Appendix C. The results indicate an $F_{.9}(1,30)$ of 2.88 for the critical value F_{α}. The F-statistic value for the data set is 3.20. Since F is greater than F_{α}, with 90% certainty, evidence suggests that the productivity of a two recruiter facility is greater than a one recruiter facility. The ANOVA indicates that, in general, an advantage exists in employing two recruiter facilities instead of single recruiter facilities. Since the sample size of 34 facilities is relatively small, a larger sample of one and two recruiter facilities using data from all six districts would be useful.

F. TRANSIENT RECRUITING FACIILITY

The transient recruiting facility (TRF) is a part-time office not continually manned by a recruiter. According to the "DOD Space Management Guide" [Ref 21], it should be:

> no larger than a 1-person office, be located in sparsley populated areas, and be used fewer then five days a week. The potential for additional recruits should be mission essential and worth the cost of acquiring and maintaining the space.

The 12th District presently has 43 TRF's. The criteria for determining the necessity of a TRF is its productivity and distance from the nearest RSS or PCS. If the TRF rates a recruiter as determined by the PQMA maximization program, then sufficient potential for additional recruits exists and the facility should be maintained. If the facility does not rate any recruiters, then a subjective determination must be made based on the proximity of the TRF to the nearest facility and its potential to attract Marine accessions.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The purpose of this study was to develop an analytical method to organize the recruiting force and reduce facilities. This was successfully accomplished by optimally allocating the recruiting force and maximizing the total PQMA available to the recruiting facilities.

The 12th Marine Corps District has a recruiting force of 419 recruiters in 246 facilities. With 1.7 recruiters per facility, it is likely that a modest reduction in facilities would not seriously hinder the district's ability to recruit. In fact, in the 10% reduction plan, none of the facilities identified for closure in Appendix D were necessary to maintain an optimal distribution of recruiters by county. In other words, recruiters could be assigned to the existing facilities less the 25 recommended for closure and, based on Equation 4.1, still be optimally allocated.

It appears likely that an increase in productivity could be accomplished while decreasing the number of facilities. This may indicate a tendency of current policy to distribute the recruiting force over a larger geographic area than necessary to obtain the best return on recruiter effort. If the command policy is to provide each high school senior easy access to a Marine recruiter then it must accept fewer accessions. Of course this study does not consider any political advantages or

requirements that may demand other than an optimal allocation of the recruiting force.

Los Angeles County appears to have more recruiters and facilities than necessary. The PQMA, if the measurement is accurate, clearly does not support the need for the assets in recruiters and facilities apportioned to the county. It is suspected that facility closures have not kept pace with changing demographics. Recruiting Station, Salt Lake City, also appears to have more facilities than the return in accessions would justify.

According to the production function, the reorganization of recruiters resulted in a 5.9% gain in category I-IIIA accessions. Although this appears to be a modest gain, if present goals remain constant, a 5% decrease in the recruiting force results in a reduction of about 20 recruiters in the district. At $45,000 per recruiter, the savings would be $900,000 per year. If these figures were very roughly extrapolated over six districts the savings could be well over five million dollars per year.

It is evident that any policy that demands the closure of all Transient Recruiting Facilities is misguided and should be reexamined. The difference between a TRF and a PCS can sometimes be elusive. Some TRF's require recruiters according to the optimal distribution model while some PCS's could be closed with little effect on productivity. Since evidence suggests that a two recruiter facility may be more productive than a one recruiter office, one solution might require two recruiters in a PCS to periodically work in a TRF. Although many TRF's could easily be closed without affecting productivity, some have the market to support a recruiter. Facility

closures should be based on the accessions the facility produces, not on the number of days per week the it is occupied.

B. RECOMMENDATIONS

The closure of 10% of the recruiting facilities would minimally affect productivity in the 12th District. The district should seriously consider closing the facilities listed in Appendix D.

The recruiting force should be aligned to exploit the location of the category I-IIIA market. The near future surely demands a smaller, more capable force which will allow the Marine Corps to focus on a better educated, higher quality force. Table 2 lists the best distribution of recruiters by county based on the nonlinear production function. This redistribution should be accomplished in a phased process to minimize the disruption to the recruiting force and better plan new recruiter assignments.

Data should be collected on accessions below county level to the individual facility. Such data would present a better view of a facility's worth and necessity.

Additional research can be conducted on the factors affecting productivity. Such data as number of high school seniors per county could be combined with PQMA to give a more current "real time" appraisal of the recruiting market in a county. County unemployment rates might also assist in explaining enlistment propensity at the county level. Analysis could be accomplished on facility and manpower costing to determine the most economical means of meeting enlistment goals and "draw down" requirements. Considering the potential gain to the Marine

Corps Recruiting Service, the research on recruiter and facility allocations should be expanded to all six districts.

APPENDIX A. PROGRAM RECRUITER PRODUCTION

This appendix displays a program that optimally distributes the recruiting force by county.

```
$TITLE
$STITLE
*-----------GAMS AND DOLLAR CONTROL OPTIONS--------------------------
*                (See Appendice B & C)

$OFFUPPER OFFSYMLIST OFFSYMXREF

OPTIONS
    LIMCOL = 0 , LIMROW  = 0  , SOLPRINT = On, DECIMALS = 2
    RESLIM =  1000, ITERLIM = 100000, OPTCR    = 0.1 , SEED     = 3141;

*------------DEFINITIONS AND DATA------------------------------------
SET
   I  AREA  /1*40,44*301/



ALIAS (I,J);

PARAMETER

  QFAC(I)  qualified prospects per facility in area I

  /1=25,2=1702,
```

3=62,4=87,

5=491, 6=80, 7=3,

8=480, 9=76,10=24,11=66,12=126,13=36,14=4, 15=7,

17=3, 16=19, 18=8, 19=338, 20=136, 21=57,22=68,

23=486,24=164,

25=726, 26=1, 27=244, 28=208, 29=59

30=264, 31=1,32=18,33=88,34=45,35=16, 36=01, 37=1052,

40=354,

38=1, 39=1,

44=69,45=944,

46=1471,

47=485,

48=60, 49=88, 50=252, 51=70,

52=434, 53=263, 54=68, 55=69, 56=67, 57=184,

58=230,59=37,60=55,61=215,62=267, 63=686,

64=172, 65=413,

66=121, 67=30, 68=32, 69=233, 70=77,

71=33, 72=44, 73=01, 74=15, 75=23, 76=4, 77=11, 78=17, 79=1, 80=23,

81=2, 82=9, 83=6, 84=3, 85=6, 86=7, 87=22, 88=8, 89=854,

90=97, 91=63,

92=321, 93=116, 94=81, 95=59, 96=348, 97=452,

98=207, 99=31, 100=66, 101=137, 102=173, 103=70,

104=76, 105=51, 106=36,107=211, 108=15, 109=47,110=5,

111=17, 112=15, 113=31, 114=5, 115=19, 116=34, 117=42, 118=3, 119=30,

120=4, 121=25, 122=4, 123=62, 124=14, 125=17, 126=4, 127= 9, 128=32,

129=32, 130=18, 131=19, 132=5, 133=47, 134=107, 135=319,

136=655,137=130,

138=46, 139=312, 140=54, 141=52, 142=239, 143=100, 144=215,

145=71, 146=22, 147=141,148=28,149=22,150=172,

151=52, 152=52, 153=156, 154=1, 155=18, 156=18, 157=10, 158=8,

159=15, 160=50, 161=7, 162=8, 163=3, 164=14, 165=1, 166=50, 167=11,

168=33, 169=21, 170=23, 171=20, 172=245, 173=82, 174=86, 175=64,

176=46, 177=117, 178=43, 179=49, 180=9, 181=102, 182=70,

```
183=77, 184=89, 185=28, 186=24, 187=9, 188=18, 189=422,
190=90, 191=113, 192=3, 193=3, 194=27, 195=4, 196=1, 197=7,
198=2, 199=1, 200=11, 201=1, 202=17, 203=22, 204=5, 205=6, 206=17,
207=12, 208=19, 209=16, 210=6, 211=1, 212=9, 213=2, 214=1, 215=15,
216=14, 217=2, 218=9, 219=12, 220=4, 221=1, 222=6, 223=5, 224=6, 225=12,
226=8, 227=2, 228=5, 229=1, 230=19, 231=1, 232=10, 233=1, 234=9, 235=3,
236=5, 237=18, 238=3, 239=25, 240=3, 241=29, 242=3, 243=3, 244=1,
245=5, 246=9, 247=17, 248=1, 249=10, 250=5, 251=2, 252=8, 253=1, 254=30,
255=9, 256=14, 257=12, 258=5, 259=3, 260=3, 261=2, 262=10, 263=7,
264=1, 265=8, 266=1, 267=6, 268=1, 269=8, 270=1, 271=4, 272=4,
273=4, 274=15, 275=6, 276=1, 277=12, 278=12, 279=1, 280=01, 281=14,
282=5, 283=2, 284=5, 285=8, 286=2, 287=12, 288=3, 289=1, 290=1,
291=1, 292=9, 293=6, 294=12, 295=23, 296=15, 297=3, 298=7, 299=1,
300=14, 301=12/ ;


 SCALARS

    ALPHA  RECRUITER ELASTICITY /0.627/
    BETA   PQMA ELASTICITY /.489/
    NREC   TOTAL NUMBER OF RECRUITERS /416/;

**------------------------- MODEL----------------------------------
 VARIABLE
    MARACC total Marine accessions from all areas
    R(I)   number of recruiters in area i;
 POSITIVE VARIABLE R(I);

 R.L(I) = 1.0;
 R.LO(I) = 1E-10;
 R.UP('2') = 38;
 R.UP('97') = 8;
 R.UP('89') = 30;
 R.UP('136') = 16;
```

```
R.UP('46') = 41;
R.UP('45') = 23;
R.UP('37') = 27;
R.UP('25') = 18;
R.UP('8') = 8;
R.UP('5') = 12;


EQUATIONS
   OBJ        calculate the number of Marine accessions
   DISREC     distribute the recruiters;

   OBJ..
       MARACC =E=
       SUM(I$(QFAC(I) NE 0), ((QFAC(I)**BETA) * (R(I) ** ALPHA)));

   DISREC..

        SUM(I,R(I)) =L= NREC;


   MODEL RECRUITER /ALL/;

   SOLVE RECRUITER USING DNLP MAXIMIZING MARACC;

   PARAMETER REPORT(*,*) ;
   REPORT(I,'RECRUITERS') = R.L(I);
   REPORT(I,'MARINE ACC') = (QFAC(I)**BETA) * (R.L(I) ** ALPHA);
   REPORT('TOTAL','MARACC') = SUM(I,REPORT(I,'MARACC'));
   DISPLAY REPORT;
```

APPENDIX B. PROGRAM GREEDY

This appendix displays a program which allocates the recruiting force to yield the maximum return in Marine accessions.

```
      PROGRAM GREEDY
*     CAPTAIN JAMES M DOLL, USMC
*
*     THIS PROGRAM DISTRIBUTES EACH SUCCESSIVE RECRUITER TO THE COUNTY
*     WHICH YIELDS THE GREATEST MARGINAL INCREASE IN MARINE ACCESSIONS
*
      INTEGER NUMREC, PQMA(301), I, SUM, CTY, COUNTY, J
      REAL  DELTA, RECR(301), BETA, ALPHA, MARACC
      NUMREC = 416
      ALPHA = 0.627
      BETA = 0.489
      OPEN (UNIT=10, FILE = '/NONLIN LISTING')
      OPEN (UNIT=11, FILE = '/RECR DATA')
      OPEN (UNIT=12, FILE = '/RECOUT DATA')
      I=1
      DO 10 J=1,301
         READ(10,*,END=20) COUNTY, RECR(J)
         READ(11,*,END=20) COUNTY, PQMA(J)
   10 CONTINUE
   12 CONTINUE
      DELTA = 0.0
      DO 15 I = 1,301
```

```
* RESTRICTION ON MAXIMUM NUMBER OF RECRUITERS TO A COUNTY

          IF ((RECR(2) .GE. 38 .AND. I .EQ. 2)
     &       .OR. (RECR(97) .GE. 8 .AND. I .EQ. 97)
     &       .OR. (RECR(89) .GE. 30 .AND. I .EQ. 89)
     &       .OR. (RECR(136) .GE. 16 .AND. I .EQ. 136)
     &       .OR. (RECR(46) .GE. 41 .AND. I .EQ. 46)
     &       .OR. (RECR(45) .GE. 23 .AND. I .EQ. 45)
     &       .OR. (RECR(37) .GE. 27 .AND. I .EQ. 37)
     &       .OR. (RECR(25) .GE. 18 .AND. I .EQ. 25)
     &       .OR. (RECR(8)  .GE. 8 .AND. I .EQ. 8)
     &       .OR. (RECR(5) .GE. 12 .AND. I .EQ. 5))THEN
*
             GOTO 15
          ELSE
             RECR(I) = INT(RECR(I))
             DELACC = (PQMA(I)**BETA*(RECR(I)+1)**ALPHA)-
     &       (PQMA(I)**BETA*RECR(I)**ALPHA)
*
* USE THE COUNTY THAT YIELDS THE GREATEST RETURN FOR AN ADDITIONAL
* RECRUITER
*
                IF(DELACC .GE. DELTA)THEN
                   DELTA=DELACC
                   CTY=I
                ENDIF
          ENDIF
   15  CONTINUE
   20  RECR(CTY) = RECR(CTY) + 1
       WRITE(12, *)'CTY',CTY,'RECR ',RECR(CTY)
       SUM = 0
       DO 30 J=1,301
          SUM = SUM + RECR(J)
```

```
30  CONTINUE
    IF(SUM .LT. NUMREC)THEN
       GO TO 12
    ENDIF
    DO 40 J=1,301
       WRITE (12,*) J, INT(RECR(J))
40  CONTINUE
    RETURN
    END
```

APPENDIX C: ANALYSIS OF VARIANCE

FY 90 Category I-IIIA Productivity

One Recruiter Facility		Two Recruiter Facility
0	1	17.5
13	2	11.5
9	2	8.5
9	12	15.5
10	21	4.0
13	1	11.0
7	2	24.5
12	2	12.5
13	7	2.5
13	4	
7	8	
	7	

$T_1 = 176$	Total Productivity	$T_2 = 107.5$
$n_1 = 23$	Number of Facilities	$n_2 = 9.0$
$T_1 = 7.65$	Mean Productivity	$T_2 = 11.94$

$(\sum X_i)^2 = 80{,}372$

$CM = 80{,}372 \div 32 = 2511.6$

$\sum(X_i^2) = 3{,}628.75$

where

X_i = Productivity of facility i

CM = Correction for the mean

Total Sums of Squares:

$$(\sum X_i)^2 - CM = 3628.75 - 2511.6 = 1117.2$$

Treatment Sums of Squares:

$$SST = (\sum T_i^2 \div n_i) - CM = 2630.8 - 2511.6 = 119.2$$

Error Sums of Squares:

$$SSE = \text{Total SS} - SST = 1117.2 - 119.2 = 998$$

Mean Squares for Treatments:

$$MST = SST \div (k-1) = 119 \div 1 = 119$$

k - 1 degrees of freedom

Mean Squares for Error:

$$MSE = SSE \div \{(n_1 + n_2) - 2\} = 1117.2 \div 30 = 37.25$$

$$F = MST \div MSE = 119 \div 37.25 = 3.20 \qquad F_{.9} = 2.88$$

$$F \geq F_\alpha$$

APPENDIX D. PROGRAM FACILITY ALLOCATION

This appendix displays a program that maximizes the available PQMA based on a 10% reduction in existing recruiting facilities.

```
$TITLE
$STITLE
*-----------GAMS AND DOLLAR CONTROL OPTIONS--------------------------
*               (See Appendice B & C)

$OFFUPPER OFFSYMLIST OFFSYMXREF

OPTIONS
    LIMCOL =  0   , LIMROW  = 0     , SOLPRINT = OFF  , DECIMALS = 2
    RESLIM =  100, ITERLIM = 10000, OPTCR     = 2.1  , SEED     = 3141;

*------------DEFINITIONS AND DATA-----------------------------------
 SET
   I  AREA  /1,40201*40209,40301,40302,4,7,0501*0503,0801,0802,9*18,1902,
             6,1901,2001,2002,21,2201,2202,2301*2306,2401,2402,2501*2505,
             26,2701*2703,2801,2802,29,3001*3003,31*36,3701*3707,
             38,39,4001*4003,44,4501*4505,4601*4611,4701*4705,48,49,
             5001,5002,51,5201*5203,53*61,6201*6202,6301*6331,
             6401,6402,6501*6504,66*68,6901*6902,70*88,
             8901*8908,90,91,9201*9202,93*95,9601*9602,
             9701,9702,9801,9802,99*106,10701*10702,108*133,
             13401*13402,13501*13502,13601*13604,13701,13702,
             138,13901,13902,140*144,14501,14502,146*149,
             15001,15002,151*173,17401,17402,175,17601,17602,177*188,
             18901*18903,190*301    /
    E(I) area with existing station
```

```
/40201*40209,40301,40302,4,7,0501*0503,0801,0802,9*12,1902,
 6,1901,2001,2002,21,2201,2202,2301*2306,2401,2402,2501*2505,
 2701*2703,2801,2802,29,3001*3003,31*33,35,36,3701*3707,
 38,39,4001*4003,44,4501*4505,4601*4611,4701*4705,48,49,
 5001,5002,51,5201*5203,53*61,6201*6202,6301*6331,
 6401,6402,6501*6504,66*68,6901*6902,70,
 8901*8908,90,91,9201*9202,93*95,9601*9602,
 9701,9702,9801,9802,99*106,10701*10702,
 13401*13402,13501*13502,13601*13604,13701,13702,
 138,13901,13902,140*144,14501,14502,146*149,
 15001,15002,151*153,172*173,17401*17402,175,17601,17602,
 177*188,18901*18903,190*191 /



   N(I) area without a station;
   N(I) = YES$(NOT E(I));
ALIAS (I,J);

SET  LA(I)    LA county /6301*6331/
     ORG(I)   Orange county /4601*4611/;

PARAMETER
  ADJ(I,I) adjacent areas
          /40201.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40202.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40203.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40204.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40205.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40206.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40207.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40208.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40209.(40201*40209,0501*0503,44,15,9,13,4) = 1
           40301.(40301,40302,15,9,6) = 1
```

40302.(40302,40301,15,9,6) = 1

4.(4,40201*40209,0501*0503,13,10,12) = 1

0501.(0501*0503,44,40201*40209,4,10,12,16) = 1

0502.(0501*0503,44,40201*40209,4,10,12,16) = 1

0503.(0501*0503,44,40201*40209,4,10,12,16) = 1

6.(6,9,40301,40302,11,13) = 1

7.(7,0801*0802,18,273) = 1

0801.(0801,0802,7,18) = 1

0802.(0802,0801,7,18) = 1

9.(40201*40209,40301,40302,6,9,13) = 1

10.(1,4,0501*0503,10,12,13,14) = 1

11.(11,1,6,13) = 1

12.(12,0501*0503,4,10) = 1

1901.(1901,1902,2301*2306,13601*13604,3001,3002) = 1

1902.(1901,1902,2301*2306,13601*13604,3001,3002) = 1

2001.(2001,2002,35,36,66,140,160,13501,13502) = 1

2002.(2001,2002,35,36,66,140,160,13501,13502) = 1

21.(21,2201,2202,9,2801,2802,3001,3002,34,151,157) = 1

2201.(2201,2202,2801,2802,21,2401,2402) = 1

2202.(2201,2202,2801,2802,21,2401,2402) = 1

2301.(2301*2306,1901,1902,2401,2402,2501*2505,2701,2702,
142,144)=1

2302.(2301*2306,1902,1901,2401,2402,2501*2504,2701,2702,
142,144)=1

2303.(2301*2306,1901,1902,2401,2402,2501*2504,2701,2702,
142,144)=1

2304.(2301*2306,1901,1902,2401,2402,2501*2504,2701,2702,
142,144)=1

2305.(2301*2306,1901,1902,2401,2402,2501*2504,2701,2702,
142,144)=1

2306.(2301*2306,1901,1902,2401,2402,2501*2504,2701,2702,
142,144)=1

2401.(2401,2402,2201,2202,2301*2306,2701,2702) = 1

2402.(2401,2402,2201,2202,2301*2306,2701,2702) = 1

2501.(2501*2505,2001,2002,9,2301*2306,2701,2702,
35,36,142*144) = 1

2502.(2501*2505,2001,2002,2301*2306,2701,2702,35,
36,142*144)=1

2503.(2501*2505,2001,2002,2301*2306,2701,2702,35,36,142,
143,144) = 1

2504.(2501*2505,2001,2002,2301*2306,2701,2702,35,
36,142*144) = 1

2505.(2501*2505,2001,2002,2301*2306,2701,2702,35,
36,142*144) = 1

2701.(2701*2703,2301*2306,2401,2402,2501*2505,36) = 1

2702.(2701*2703,2301*2306,2401,2402,2501*2505,36) = 1

2703.(2701*2703,2301*2306,2401,2402,2501*2505,36) = 1

2801.(2801,2802,21,2201,2202,29,34) = 1

2802.(2801,2802,21,2201,2202,29,34) = 1

29.(29,2801,2802,33,34,146,158,167) = 1

3001.(3001*3003,1901,1902,13601*13604,151,21,
2801,2802,142) = 1

3002.(3001*3003,1901,1902,13601*13604,151,
21,2801,2802,142) = 1

3003.(3001*3003,1901,1902,13601*13604,151,
21,2801,2802,142) = 1

31.(31,18,272,273,269) = 1

32.(32,33,152) = 1

33.(33,32,29,152,167) = 1

36.(2001*2002,2501*2505) = 1

3701.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

3702.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

3703.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

3704.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

3705.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

3706.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

3707.(3701*3707,4501*4505,4601*4611,4701*4705,6301*6331) = 1

4001.(4001*4003) = 1

4002.(4001*4003) = 1

4003.(4001*4003) = 1

44.(44,40201*40209,0501*0503,15,48) = 1

4501.(4501*4505,3701*3707,4701*4705,6301*6331,
13501,13502,159)=1

4502.(4501*4505,3701*3707,4701*4705,6301*6331,
13501,13502,159)=1

4503.(4501*4505,3701*3707,4701*4705,6301*6331,
13501,13502,159) = 1

4504.(4501*4505,3701*3707,4701*4705,
6301*6331,13501*13502,159) = 1

4505.(4501*4505,3701*3707,4701*4705,
6301*6331,13501,13502,159) = 1

4601.(4601*4611,48,4701*4705,3701*3707) = 1

4602.(4601*4611,48,4701*4705,3701*3707) = 1

4603.(4601*4611,48,4701*4705,3701*3707) = 1

4604.(4601*4611,48,4701*4705,3701*3707) = 1

4605.(4601*4611,48,4701*4705,3701*3707) = 1

4606.(4601*4611,48,4701*4705,3701*3707) = 1

4607.(4601*4611,48,4701*4705,3701*3707) = 1

4608.(4601*4611,48,4701*4705,3701*3707) = 1

4609.(4601*4611,48,4701*4705,3701*3707) = 1

4610.(4601*4611,48,4701*4705,3701*3707) = 1

4611.(4601*4611,48,4701*4705,3701*3707) = 1

4701.(4701*4705,15,3701*3707,4501*4505,4601*4611,48) = 1

4702.(4701*4705,15,3701*3707,4501*4505,4601*4611,48) = 1

4703.(4701*4705,15,3701*3707,4501*4505,4601*4611,48) = 1

4704.(4701*4705,15,3701*3707,4501*4505,4601*4611,48) = 1

4705.(4701*4705,15,3701*3707,4501*4505,4601*4611,48) = 1

48.(48,15,44,4601*4611,4701*4705) = 1

49.(49,51,53,6201,6202,71,88) = 1

5001.(5001,5002,5201*5203,56,58,67,72,80) = 1

5002.(5001,5002,5201*5203,56,58,67,72,80) = 1

51.(51,49,53,55,74,83,86,88) = 1

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57.(57,54,55,61) = 1

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61.(61,53,54,55,57,73,75) = 1

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6311.(6301*6331) = 1

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67.(67,5001,5002,72,80) = 1

68.(68,58,6201,6202,79,81,87,88) = 1

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8901.(8901*8908,9201,9202,9701,9702,100,101,125) = 1

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94.(94,93,100,101,115,121,125,127) = 1

95.(95,90,9201,9202,123,129,132) = 1

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9602.(9601,9602,59,104,108,109,115,127,131,133) = 1

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117,123,124,128) = 1

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100.(100,8901*8908,9201,9202,94,95,119,125,129) = 1

101.(101,77,78,8901*8908,91,93,94,9701,9702,125) = 1

102.(102,91,9701,9702,103,128) = 1

103.(103,91,102,124,128,130) = 1

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105.(105,91,106,111,112,116,122) = 1

106.(106,105,108,111,113) = 1

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13702.(13701,13702,140,143,148,161,163) = 1

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141.(141,13401,13402,13901,13902,153,165,166) = 1

142.(142,144,2501*2504,2301*2305,1901,1902,

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146.(146,164,167,149,147,29,158,138) = 1

147.(147,146,167,149,162,13701,13702,152) = 1

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173.(173,205,208,199,194,211,215,221,197) = 1

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180.(180,253,243,255,267) = 1
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182.(182,181,208,244,225,252) = 1
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184.(184,252,215,239,236,254,258) = 1
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291=1, 292=9, 293=6, 294=12, 295=23, 296=15, 297=3, 298=7, 299=0,
300=14, 301=12/ ;


 SCALARS

    NSTA   number of recruiting facilities to open /200/;

**------------------------ MODEL----------------------------------
 BINARY VARIABLE
    X(I)  indicate a facility manned in area i
    Y(I)  indicate if area I is recruited from an adjacent area;

    X.FX(N) = 0;

 VARIABLE
    TOTQUA  total qualified individuals served form all stations;

 EQUATIONS
    OBJ  calculate the number of enlistable individuals served
    BRANCH(I) allows an area to be recruited if accessible from i
    EITHER(I)  area that has a facility cannot be recruitable from other area
    OPENST  open an allowable number of stations
    FACMIN  open a minimum number of facilities in county;
```

```
OBJ..
    TOTQUA =E= SUM(I,X(I)*QFAC(I) + 0.3*Y(I)*QFAC(I));

BRANCH(I)..
     SUM(J,ADJ(I,J)*X(J)) =G= Y(I);
OPENST..
     SUM(I,X(I)) =L= NSTA;
EITHER(I)..
     X(I) + Y(I) =L= 1;
FACMIN..
     SUM(LA,X(LA)) =G= 20;
MODEL RECRUIT /ALL/;
SOLVE RECRUIT USING MIP MAXIMIZING TOTQUA;

PARAMETER REPORT(*,*) ;
REPORT(I,'FAC') = X.L(I);
REPORT(I,'BRANCH') = Y.L(I);
REPORT(I,'TOTQUAL') = QFAC(I)*(X.L(I)+Y.L(I));
REPORT('TOTAL','FAC') = SUM(I,REPORT(I,'FAC'));
REPORT('TOTAL','BRANCH') = SUM(I,REPORT(I,'BRANCH'));
REPORT('TOTAL','TOTQUAL') = SUM(I,REPORT(I,'TOTQUAL'));
REPORT('LA','FAC') = SUM(LA,REPORT(LA,'FAC'));
REPORT('Orange','FAC') = SUM(ORG,REPORT(ORG,'FAC'));
DISPLAY REPORT;
```

APPENDIX E

FACILITIES RECOMMENDED FOR CLOSURE IN THE 12^{TH} DISTRICT

Facility	Name	County	Recruiting Station
PCS	Alhambra	LA	LA
PCS	Palmdale	LA	LA
PCS	Metro	LA	LA
PCS	Newhall	LA	LA
PCS	N. Hollywood	LA	LA
PCS	La Puente	LA	LA
PCS	Canoga Park	LA	LA
TRF	Bishop	Honolulu	Orange
TRF	San Clemente	Orange	Orange
PCS	Henderson	Lincoln	Phoenix
TRF	Lake Havasu	Mohave	Phoenix
TRF	Seaside	Clatsop	Portland
TRF	The Dalles	Wasco	Portland
TRF	Sanora	Tuolume	Sacramento
TRF	Susanville	Lassen	Sacramento
TRF	Glendive	Dawson	Salt Lake
PCS	La Grande	Union	Salt Lake
TRF	Ontario	Malheur	Salt Lake
PCS	Cedar City	Iron	Salt Lake
RSS	Logan	Cache	Salt Lake
TRF	Clear Lake	Ureka	San Francisco
TRF	Crescent City	Delnorte	San Francisco
PC	Livermore	Alameda	San Francisco
PCS	San Leandro	Alameda	San Francisco
TRF	Walla Walla	Walla Walla	Seattle
TRF	Latah	Moscow	Seattle

TABLE I
FISCAL YEAR 1990 FACILITY AND ACCESSION DATA

County	Accessions	PQMA	Recruiter Manning Level RSS	Recruiter Manning Level PCS	Number of TRF's	Number of Facilities	Number of Recruiters
1	1	398	0	0	0	0	0
2	326	27,091	16	10	0	9	26
3	6	987	0	0	2	2	0
4	24	1,385	0	0	1	1	0
5	82	7,815	7	1	0	3	8
6	8	1,273	3	0	0	1	3
7	0	48	0	1	0	1	1
8	78	7,656	6	0	0	2	6
9	13	1,210	0	1	0	1	1
10	3	382	0	0	1	1	0
11	9	1,051	0	0	1	1	0
12	18	2,006	0	0	1	1	0
13	8	573	0	0	0	0	0
14	4	64	0	0	0	0	0
15	0	111	0	0	0	0	0
16	3	302	0	0	0	0	0
17	1	48	0	0	0	0	0
18	0	127	0	0	0	0	0
19	73	5,396	0	3	0	2	3
20	12	2,181	1	1	0	2	2
21	9	907	0	1	0	1	1
22	6	1,098	0	1	1	2	1
23	101	7,736	5	3	0	5	8
24	19	2,626	0	2	0	2	2
25	114	9,773	6	3	0	4	9
26	0	0	0	0	0	0	0
27	32	3,884	1	1	0	2	2
28	35	3,311	3	0	1	2	3
29	6	939	0	0	1	1	0
30	36	4,202	3	2	0	2	5
31	0	0	0	0	1	0	0
32	4	287	0	0	1	1	0
33	35	1,401	2	0	0	1	2
34	3	716	0	0	0	0	0
35	4	255	0	0	0	0	0
36	18	1,783	0	0	0	0	0
37	160	16,713	20	4	0	7	24
38	0	48	2	0	0	1	2
39	9	780	0	1	0	1	1
40	30	4,218	2	3	2	5	5
41	5	589	0	0	1	1	0
42	0	0	0	0	0	0	0
43	2	239	0	0	0	0	0
44	10	1,098	0	1	0	1	1
45	109	15,026	3	4	2	6	7
46	249	23,399	12	7	0	11	19
47	107	7,720	7	2	0	5	9
48	13	955	3	0	0	1	3
49	23	1,401	2	0	0	1	2
50	39	4,011	5	0	0	2	5
51	13	1,114	0	1	0	1	1
52	65	6,924	5	2	0	3	7
53	45	4,186	4	0	0	1	4
54	12	1,082	0	0	1	1	0

County	Accessions	PQMA	Recruiter Manning Level RSS	Recruiter Manning Level PCS	Number of TRF's	Number of Facilities	Number of Recruiters
55	11	1,098	0	0	1	1	0
56	5	1,066	0	0	1	1	0
57	17	2,929	2	0	0	1	2
58	31	3,661	2	0	0	1	2
59	6	589	0	0	1	1	0
60	7	875	0	1	0	1	1
61	8	1,958	2	0	0	1	2
62	33	4,250	4	0	0	2	4
63	46	4,488	20	21	0	31	41
64	38	2,738	0	2	0	2	2
65	76	6,574	2	5	0	4	7
66	12	1,926	0	0	1	1	0
67	7	478	0	0	1	1	0
68	0	509	0	0	1	1	0
69	41	3,709	6	0	0	2	6
70	12	1,226	0	1	0	1	1
71	11	525	0	0	0	0	0
72	16	700	0	0	0	0	0
73	9	1,464	0	0	0	0	0
74	0	239	0	0	0	0	0
75	0	366	0	0	0	0	0
76	1	64	0	0	0	0	0
77	0	175	0	0	0	0	0
78	3	271	0	0	0	0	0
79	1	16	0	0	0	0	0
80	2	366	0	0	0	0	0
81	1	32	0	0	0	0	0
82	0	143	0	0	0	0	0
83	1	95	0	0	0	0	0
84	0	48	0	0	0	0	0
85	2	95	0	0	0	0	0
86	2	111	0	0	0	0	0
87	0	350	0	0	0	0	0
88	3	127	0	0	0	0	0
89	118	13,593	12	7	0	8	19
90	10	1,544	0	1	0	1	1
91	3	1,003	0	1	0	1	1
92	58	5,109	3	1	0	2	4
93	15	1,846	2	0	0	1	2
94	7	1,289	0	1	0	1	1
95	2	939	0	0	1	1	0
96	50	5,539	3	1	0	2	4
97	71	7,195	4	1	0	2	5
98	11	3,279	1	1	0	2	2
99	1	493	0	0	1	1	0
100	4	1,051	0	1	0	1	1
101	19	2,181	3	0	0	1	3
102	15	2,754	3	0	0	1	3
103	1	1,114	0	0	1	1	0
104	9	1,210	0	1	0	1	1
105	7	812	0	1	0	1	1
106	0	573	0	0	1	1	0
107	73	4,950	4	1	0	2	5
108	0	239	0	0	0	0	0
109	4	748	0	0	0	0	0
110	0	80	0	0	0	0	0
111	3	271	0	0	0	0	0
112	3	239	0	0	0	0	0

County	Accessions	PQMA	Recruiter Manning Level RSS	Recruiter Manning Level PCS	Number of TRF's	Number of Facilities	Number of Recruiters
113	3	493	0	0	0	0	0
114	1	80	0	0	0	0	0
115	2	302	0	0	0	0	0
116	2	541	0	0	0	0	0
117	5	669	0	0	0	0	0
118	2	48	0	0	0	0	0
119	4	478	0	0	0	0	0
120	1	64	0	0	0	0	0
121	9	398	0	0	0	0	0
122	0	64	0	0	0	0	0
123	5	987	0	0	0	0	0
124	4	223	0	0	0	0	0
125	2	271	0	0	0	0	0
126	0	64	0	0	0	0	0
127	1	143	0	0	0	0	0
128	5	509	0	0	0	0	0
129	3	509	0	0	0	0	0
130	4	287	0	0	0	0	0
131	5	302	0	0	0	0	0
132	1	80	0	0	0	0	0
133	8	748	0	0	0	0	0
134	21	1,703	0	2	0	2	2
135	51	5,078	3	1	0	2	4
136	104	10,426	7	2	0	4	9
137	20	2,069	0	2	0	2	2
138	11	732	0	0	1	1	0
139	51	4,966	4	1	0	2	5
140	12	860	3	0	0	1	3
141	11	828	0	0	1	1	0
142	46	3,804	3	1	0	2	4
143	22	1,592	2	0	0	1	2
144	49	3,422	2	0	0	1	2
145	22	1,130	1	0	1	2	1
146	13	350	0	1	0	1	1
147	25	2,244	0	2	0	1	2
148	7	446	0	0	1	1	0
149	3	350	0	0	1	1	0
150	28	2,738	3	0	1	2	3
151	13	828	0	1	0	1	1
152	7	828	0	1	0	1	1
153	36	2,483	3	0	0	1	3
154	0	0	0	0	0	0	0
155	4	287	0	0	0	0	0
156	3	287	0	0	0	0	0
157	1	159	0	0	0	0	0
158	1	127	0	0	0	0	0
159	4	239	0	0	0	0	0
160	15	796	0	0	0	0	0
161	1	111	0	0	0	0	0
162	4	127	0	0	0	0	0
163	0	48	0	0	0	0	0
164	4	223	0	0	0	0	0
165	3	0	0	0	0	0	0
166	5	796	0	0	0	0	0
167	1	175	0	0	0	0	0
168	11	525	0	0	0	0	0
169	1	334	0	0	0	0	0
170	5	366	0	0	0	0	0

County	Accessions	PQMA	Recruiter Manning Level RSS	Recruiter Manning Level PCS	Number of TRF's	Number of Facilities	Number of Recruiters
171	3	318	0	0	0	0	0
172	41	3,900	3	0	0	1	3
173	1	1,305	0	1	0	1	1
174	9	1,369	2	0	1	2	2
175	5	1,019	2	0	0	1	2
176	3	732	4	0	1	2	4
177	18	1,862	3	0	0	1	3
178	2	684	0	1	0	1	1
179	2	780	0	1	0	1	1
180	0	143	0	0	1	1	0
181	18	1,624	0	0	1	1	0
182	12	1,114	0	1	0	1	1
183	21	1,226	0	1	0	1	1
184	9	1,417	4	0	0	1	4
185	1	446	0	1	0	1	1
186	2	382	0	0	1	1	0
187	2	143	0	1	0	1	1
188	2	287	1	0	0	1	1
189	52	5,348	8	0	0	3	8
190	9	1,433	3	0	0	1	3
191	21	1,799	3	0	0	1	3
192	0	48	0	0	0	0	0
193	0	48	0	0	0	0	0
194	4	430	0	0	0	0	0
195	0	64	0	0	0	0	0
196	0	0	0	0	0	0	0
197	0	111	0	0	0	0	0
198	0	32	0	0	0	0	0
199	2	16	0	0	0	0	0
200	4	175	0	0	0	0	0
201	0	0	0	0	0	0	0
202	2	271	0	0	0	0	0
203	2	350	0	0	0	0	0
204	0	80	0	0	0	0	0
205	1	95	0	0	0	0	0
206	0	271	0	0	0	0	0
207	0	191	0	0	0	0	0
208	4	302	0	0	0	0	0
209	1	255	0	0	0	0	0
210	0	95	0	0	0	0	0
211	2	16	0	0	0	0	0
212	0	143	0	0	0	0	0
213	0	32	0	0	0	0	0
214	0	0	0	0	0	0	0
215	0	239	0	0	0	0	0
216	3	223	0	0	0	0	0
217	0	32	0	0	0	0	0
218	0	143	0	0	0	0	0
219	0	191	0	0	0	0	0
220	2	64	0	0	0	0	0
221	0	16	0	0	0	0	0
222	1	95	0	0	0	0	0
223	0	80	0	0	0	0	0
224	2	95	0	0	0	0	0
225	1	191	0	0	0	0	0
226	1	127	0	0	0	0	0
227	0	32	0	0	0	0	0
228	0	80	0	0	0	0	0

County	Accessions	PQMA	Recruiter Manning Level RSS	Recruiter Manning Level PCS	Number of TRF's	Number of Facilities	Number of Recruiters
229	0	16	0	0	0	0	0
230	1	302	0	0	0	0	0
231	0	16	0	0	0	0	0
232	1	159	0	0	0	0	0
233	0	0	0	0	0	0	0
234	2	143	0	0	0	0	0
235	0	48	0	0	0	0	0
236	0	80	0	0	0	0	0
237	0	287	0	0	0	0	0
238	0	48	0	0	0	0	0
239	2	398	0	0	0	0	0
240	0	48	0	0	0	0	0
241	1	462	0	0	0	0	0
242	0	48	0	0	0	0	0
243	0	48	0	0	0	0	0
244	0	16	0	0	0	0	0
245	0	80	0	0	0	0	0
246	0	143	0	0	0	0	0
247	1	271	0	0	0	0	0
248	0	0	0	0	0	0	0
249	0	159	0	0	0	0	0
250	1	80	0	0	0	0	0
251	0	32	0	0	0	0	0
252	3	127	0	0	0	0	0
253	1	16	0	0	0	0	0
254	2	478	0	0	0	0	0
255	2	143	0	0	0	0	0
256	5	223	0	0	0	0	0
257	2	191	0	0	0	0	0
258	0	80	0	0	0	0	0
259	1	48	0	0	0	0	0
260	3	48	0	0	0	0	0
261	0	32	0	0	0	0	0
262	1	159	0	0	0	0	0
263	0	111	0	0	0	0	0
264	1	0	0	0	0	0	0
265	0	127	0	0	0	0	0
266	0	16	0	0	0	0	0
267	1	95	0	0	0	0	0
268	0	0	0	0	0	0	0
269	2	127	0	0	0	0	0
270	0	0	0	0	0	0	0
271	3	64	0	0	0	0	0
272	0	64	0	0	0	0	0
273	1	64	0	0	0	0	0
274	3	239	0	0	0	0	0
275	0	95	0	0	0	0	0
276	0	16	0	0	0	0	0
277	1	191	0	0	0	0	0
278	0	191	0	0	0	0	0
279	0	0	0	0	0	0	0
280	9	1,528	0	0	0	0	0
281	1	223	0	0	0	0	0
282	3	80	0	0	0	0	0
283	0	32	0	0	0	0	0
284	0	80	0	0	0	0	0
285	2	127	0	0	0	0	0
286	1	32	0	0	0	0	0

County	Accessions	PQMA	Recruiter Manning Level RSS	Recruiter Manning Level PCS	Number of TRF's	Number of Facilities	Number of Recruiters
287	1	191	0	0	0	0	0
288	1	48	0	0	0	0	0
289	0	0	0	0	0	0	0
290	0	16	0	0	0	0	0
291	0	16	0	0	0	0	0
292	1	143	0	0	0	0	0
293	0	95	0	0	0	0	0
294	1	191	0	0	0	0	0
295	3	366	0	0	0	0	0
296	1	239	0	0	0	0	0
297	0	48	0	0	0	0	0
298	2	111	0	0	0	0	0
299	0	0	0	0	0	0	0
300	0	223	0	0	0	0	0
301	0	191	0	0	0	0	0

TABLE 2

COUNTY RECRUITER ALLOCATION

County	Recruiters	Recruiting Station
Maricopa	38	Phoenix
Mohave	1	
Pinal	1	
Pima	9	
Coconino	1	
Clark	8	
Yavapai	1	
Navajo	1	
Cochise	2	
Total	62	
Contra Costa	5	San Francisco
Monterey	2	
Napa	1	
Marin	1	
Alameda	9	
San Francisco	2	
Santa Clara	15	
San Mateo	4	
Sonoma	3	
Mendocino	1	
Solano	4	
Humbolt	1	
Lake	1	
Santa Cruz	1	
Total	50	
Orange	25	Orange
Hawaii	7	
Total	32	

Yuma	1	San Diego
San Bernardino	21	
San Diego	39	
Riverside	9	
Imperial	1	
Total	71	
Linn	1	Portland
Washington	4	
Deshutes	1	
Multnomah	8	
Lane	4	
Josephine	1	
Klamath	1	
Yamhill	1	
Jackson	2	
Clackamas	3	
Lincoln	1	
Umatilla	1	
Douglas	3	
Marion Polk	4	
Clark	3	
Cowlitz	1	
Coos	1	
Columbia	1	
Total	41	
King	19	Seattle
Whatcom	1	
Lewis	1	
Snohimish	5	
Benton	1	
Grant	1	
Skagit	1	
Spokane	6	
Pierce	8	
Kitsap	3	
Chelan	1	
Yakima	2	
Thurston	2	
Grays Harbor	1	
Kootenai	1	
Nez Perce	1	
Anchorage/Fairbanks	5	
Bonner	1	
Clallam	1	
Island	1	
Stevens	1	
Total	63	
Placer	1	Sacramento
Kerns	5	
Sacramento	13	
Butte	2	
Yuba	1	
Fresno	5	
Nevada	1	
Madera	1	
San Joquin	3	

Merced	1	
Stanislaus	3	
Eldorado	1	
Shasta	2	
Tulare	2	
Yolo	1	
Siskiyou	1	
Washoe	2	
Kings	1	
Sutter	1	
Total	47	
Ada	4	Salt Lake City
Bonneville	1	
Canyon	1	
Bannock	1	
Twin Falls	1	
Yellowstone	1	
Gallatin	1	
Silver Bow	1	
Cascade	1	
Lewis Clark	1	
Flathead	1	
Missoula	1	
Salt Lake	7	
Weber	1	
Utah	1	
Davis	1	
Total	25	
Los Angeles	14	Los Angeles
Santa Barbara	2	
Ventura	7	
San Luis Obispo	1	
Total	24	

LIST OF REFERENCES

1. Millett,A.; Semper Fidelis, The History of the United States Marine Corps; Macmillan Publishing Inc.,1980; pp. 618-623.

2. Quester, A., North, J; Center for Naval Analysis Briefing (91-0895); Selecting Successful Marines; 26 April 1991.

3. Ibid.

4. Horne, G.,Hughes,J.,and Sims,W.; Evaluation of the USMC QMA-Based Recruiting Goaling System and a Proposed Alternative; Center for Naval Analyses Report CRM 89-280, April 1990.

5. Schrage,L; Lindo; The Scientific Press; 1986, PP. 192-196.

6. Louveaux, F., Labbe, M. and Thisse, J.; Annals of Operations Research; "Facility Location Analysis: Theory and Applications;" Scientific Publishing Co.; V. 18; 1989.

7. Tompkins, J., White, J.; Facilities Planning; John Wiley and Sons, 1984.

8. Francis, R., White, J.;Facility Layout and Location, An Analytical Approach; Prentice-Hall Inc.; 1974.

9. Ibid, pp. 428-437.

10. Anderson, D.R.; Management Science, Quantitative Approaches to Decision Making; West Publishing Co.; 1988; pp. 334-335.

11. Studenmund,A., Cassidy,H.; Using Econometrics, A Practical Guide; Harper-Collins; 1987, pp. 114-116, 146.

12. Rolston,T.,"The Optimal Location of Coast Guard Recruiting Offices"; Master's Thesis, Naval Postgraduate School, Monterey, Ca.; 1984.

13. Systems Exploration Inc., Decision Support System Division; "Recruiter Allocation Model"; June 1991.

14. Marine Corps Market Share Report, Fiscal Year 1990; NPS Regular Male Contracts for AFQT Categories I-IIIA; Defense Manpower Data Center, Monterey, Ca.

15. No. 30 Population Projections, By Age: 1990 to 2000; Current Population Reports, series P-25, No. 1017; U.S. Bureau of the Census.

16. Lewis, J.,"An Examination of the Influence of Environmental Factors on Recruiting Category I-IIIA Males", Master's Thesis, Naval Postgraduate School, Monterey, Ca.; 1987.

17. Seo, K.K.; Managerial Economics; Irwin, Inc.; 1991; pp. 330-337.

18. Chaterjee, S., Price,B.; Regression Analysis by Example; John Wiley and Sons, Inc.; 1977; pg. 52.

19. Mendenhall, W., Wackerly, D., Scheaffer,R.; Mathematical Statistics with Applications; PWS-Kent Publishing Co., 1990; pp. 454-456.

20. Ibid; pp. 319-321.

21. Department of Defense Military Recruiting Facilities Space Management Guide, Changes to; Department of the Army, U.S. Army Corps of Engineers (CERE-AM); Oct 1991; pg 2.

22. Ref 4; Table 9; pg. 22.

23. 1992 Commercial Atlas and Marketing Guide; Rand McNally; 1991.

24. Studenmund, A., Cassidy, H.; Using Econometrics, A Practical Guide; Harper-Collins; 1987, pg. 190.

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